Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

APRIL 1978/$1

How to Design Power Supplies
Easy-to-build LED Projects
Microprocessor Microcourse, Part II

16-PAGE CB RADIO SUPPLEMENT, INCLUDING
Buyers Guide to Super CB Mobile Transceivers

Tested In This Issue

Sharp RT-3388 Computer-controlled Cassette Deck

Wharfedale E-50 High-efficiency Speaker System

Harmon-Kardon Model 730 AM/Stereo FM Receiver

Introducing the mobile that can move you out of the world of the ordinary and into the world of the serious CB'er. The Cobra 138XLR Single Sideband.

Sidebanding puts you in your own private world. A world where there's less congestion. More privacy. More time to talk.

It's all possible because instead of 40 channels you get your choice of 120 channels. Both AM and SSB. And instead of 4 watts of legal power you get 12 watts of legal power. So you get almost double the range of AM.

With the 138XLR Single Sideband there's less background noise and less interference. So there's cleaner, clearer reception. Because like all Cobras, the 138XLR SSB is engineered to punch through loud and clear. Even in crowded metropolitan areas.

And like all Cobras it comes equipped with such standard features as an easy-to-read LED channel indicator. Switchable noise blanking and limiting. An RF/signal strength meter. And Cobra's exclusive DynaMike gain control.

You'll find the 138XLR SSB wherever Cobras are sold. Which is almost everywhere. Because Cobra's got a nationwide network of dealers and Authorized Service Centers offering sales, installation, service and advice. So come on in. And move on up.

Cobra®

Punches through loud and clear.

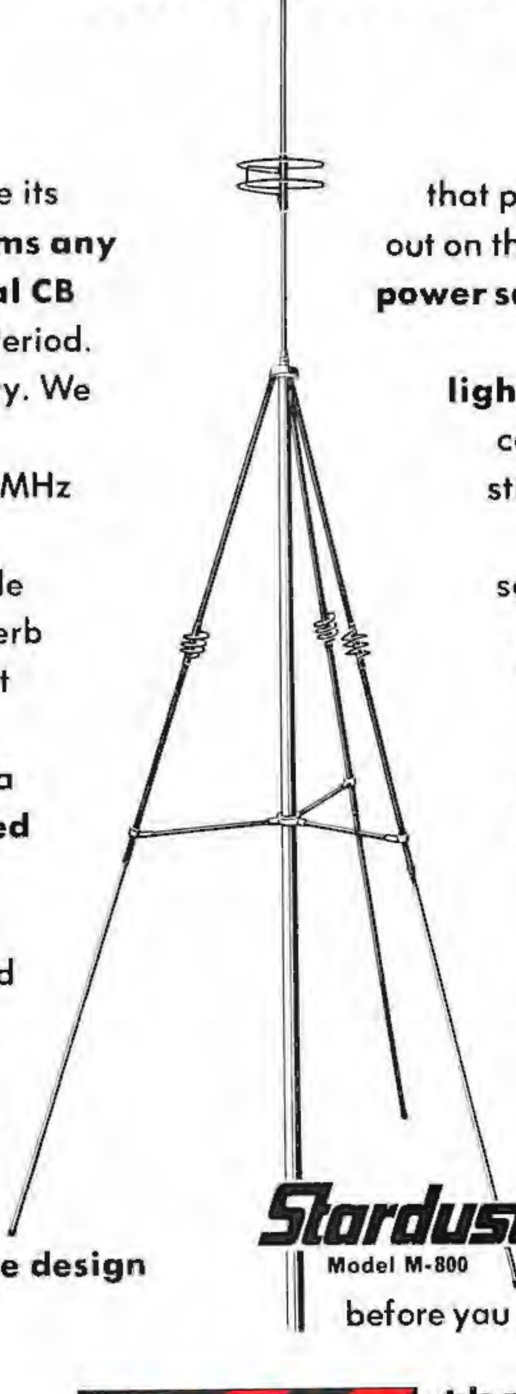
Cobra Communications Products
DYNASCAN CORPORATION
6460 W. Cortland St., Chicago, Illinois 60635

Write for color brochure
EXPORTERS: Empire • Plainview, N.Y. • **CANADA:** Atlas Electronics • Ontario

CIRCLE NO 13 ON FREE INFORMATION CARD

UPWARD MOBILITY.

If you think this is merely the world's best omni-directional CB base antenna, THINK TWICE.



STARDUSTER II. Like its famous father, **outperforms any ⅝ wave omni-directional CB antenna** ever designed. Period. But that's only half the story. We also designed it to work simultaneously on 88-108 MHz FM. **It receives FM broadcasts** right alongside your CB rig so you get superb double duty from one great antenna. FM reception is **vertically polarized** for a perfect omni pattern. **Tuned traps and phasing coil** for excellent performance across the entire band. And in case you're wondering, you still get the **STARDUSTER's fantastic CB performance.** Tremendous **5dB gain.** Our original **full aperture design** that punches your signal farther out on the horizon. Plus a **500 to 1 power safety factor.** Installation? STARDUSTER II's so super **lightweight** and compact you can carry it up a ladder and still hold onto the ladder. It's made of aircraft-grade seamless aluminum tubing, **weighs just 4.0 pounds.** You can assemble and put up this rugged beauty in minutes, and it'll stay up. **Resists 100 mph winds.** Naturally, we pack in everything you need, even the coax splitter and 300 ohm patch cable. STARDUSTER II. A great answer to two antenna needs. So shouldn't you **think twice** before you buy any other CB antenna?

Starduster II
Model M-800

the antenna specialists co.

®"Stripes of Quality"

12435 Euclid Ave., Cleveland, OH 44106 A member of the **Allen Group, Inc.**
Export: 2200 Shames Drive, Westbury, L.I. New York 11590
Canada: A. C. Simmonds & Sons, Ltd.

In 25 years...we've never been outdistanced. Professional quality antennas and accessories for police, industrial, CB, marine, amateur, aviation

CIRCLE NO. 6 ON FREE INFORMATION CARD

APRIL 1978

Popular Electronics®

VOLUME 13, NUMBER 4

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

Feature Articles

Construction Articles

Special Focus on CB Radio

Columns

Julian Hirsch Audio Reports

Electronic Product Test Reports

Departments

Coming Next Month

- MAGNETOMETERS FOR INVESTIGATING UFO'S
- MICROPROCESSOR MICROCOURSE, PART 3
- ADDING TRIGGER SWEEP TO AN OSCILLOSCOPE

TEST REPORTS:
Dynaco Stereo 416 Power Amplifier
Philips AH-673 AM/Stereo FM Tuner
Heath HW-2036 2-meter AM Transceiver
Sencore CB41 CB Performance Tester

Cover Art by George Kelvin

POPULAR ELECTRONICS, April 1978, Volume 13, Number 4, Published monthly at One Park Avenue, New York, NY 10016. One year subscription rate for U.S. and Possessions, $12.00; Canada, $15.00; all other countries, $17.00 (cash orders only, payable in U.S. currency). Second Class postage paid at New York, NY and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada, and for payment of postage in cash.

POPULAR ELECTRONICS including ELECTRONICS WORLD, Trade Mark Registered. Indexed in the Reader's Guide to Periodical Literature.

Editorial correspondence: POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. Editorial contributions must be accompanied by return postage and will be handled with reasonable care; however, publisher assumes no responsibility for return or safety of manuscripts, art work, or models.

Forms 3579 and all subscription correspondence: POPULAR ELECTRONICS, Circulation Dept., P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address. Include your old address, enclosing, if possible, an address label from a recent issue.

Popular Electronics®

ZIFF-DAVIS PUBLISHING COMPANY
Editorial and Executive Offices
One Park Avenue New York, New York 10016
212-725-3500

Midwestern Office
The Pattis Group, 4761 West Touhy Ave.,
Lincolnwood, Illinois 60646, 312 679-1100
Thomas Hockney, Michael Neri, Gerald E. Wolfe
Western Office
9025 Wilshire Boulevard, Beverly Hills, CA 90211
213-273-8050, BRadshaw 2-1161
Western Advertising Manager, Bud Dean
Japan: James Yagi
Oji Palace Aoyama, 6-25, Minami Aoyama
6 Chome, Minato-Ku, Tokyo 407-1930/6821
582-2851

Editorial

ELECTRONICS AT WINTER CES

CB radio was big at the giant Winter Consumer Electronics Show in Las Vegas. Many CB manufacturers unveiled their plans for the coming year: high-technology CB transceivers. This means that there will be a greater proportion of SSB models than before, and more models with microprocessor-based circuitry that makes possible keyboard entry functions, channel memory storage and scanning.

Furthermore, there were large exhibits of mobile underdash models, remotely controlled models, and indash models of every description. The latter included combined CB/AM/stereo FM models, many with a choice of cassette or 8-track tape players, adjustable shafts, and universal installation kits. Of particular note was the rising number of models with a channel-9 priority function.

A host of sophisticated base stations was displayed, too, extending in price to about $1000. These included microprocessor-based types with keyboard entry; models with three large, independent meters; SSB models with a VFO for receive that include a separate digital *frequency* readout; a base station with a large, blue fluorescent/digital display; and so on.

CB antenna manufacturers were not content to simply lead with dressed-up versions of last year's line, either. For example, antenna specialists showed a mobile antenna with a solid-state circuit that displayed the traditional loading coil; GTE Sylvania displayed an electronic self-tuning trunk-mount antenna that's said to automatically maintain minimum VSWR; Avanti's new "Saturn" selectable vertical/horizontal base station omni floated high in the exhibit area; Shakespeare displayed its fiberglass "City Stick" for indoor use; American Antenna's exhibit showed its K-40 models mounted in a variety of locations on an actual automobile; and two manufacturers which were formerly OEM-only makers—Harada and True Temper—entered the consumer area.

Other personal communications highlights at the show included Prime Electronic's PR-1000 variable audio filter with 40-3000-Hz Peak, Notch, Low-Pass positions; Stoner's matching-cabinet console system that adds a ham radio and an AM CB adapter to its SSB-only base station; Wilson's WR-500 rotor, with a disc-type brake; and Panasonic's 49-MHz "Walkie Talkie" entry.

Rumors were rife, too. They included development of a computer interface adapter so that CB'ers can communicate computer-to-computer over the air (there's a legality question on this, though); an FCC proposal to permit ASCII as well as Baudot; and illegal use of 27.505 MHz for Morse code practice (as if the FCC didn't have enough trouble with other violations).

In other product categories, highlights were TV receivers with dual viewing channels; a raft of high-quality auto-sound products which included power boosters and graphic equalizers for car use, scanners with microprocessors, an X/K band radar detector from Convoy that uses a parabolic antenna in a standard fog-lamp housing; no-solder BNC connectors from Cambridge; innumerable projection TV systems and VCR's; calculators with new twists such as Toshiba's LCD-display pocket notebook that stores names, addresses, and phone numbers; Cannon's mini desktop with dual displays to show memory content or calculating process figures; Casio's pocket calculator/alarm clock/timer; and Sinclair's $34.95 programmable with a library of 290 programs. Computers and games essentially joined microprocessors at the show. This will be noted next month in our "Computer Bits."

In short, this was a most exciting show, with some 550 exhibitors who used more than 300,000 sq ft of space. (About one third of the show was devoted to hi-fi equipment, covered by Ralph Hodges in this month's Stereo Scene.) So it looks like a good year coming up!

Art Salsberg

Pocket CB

New integrated circuit technology and a major electronic breakthrough brings you the world's smallest citizens band transceiver.

Scientists have produced a personal communications system so small that it can easily fit in your pocket. It's called the PocketCom, and it replaces larger units that cost considerably more.

MANY PERSONAL USES

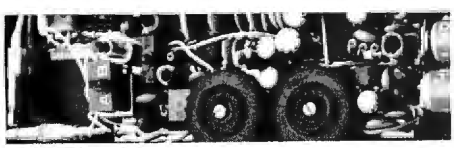
An executive can now talk with anybody in his office, his factory, or job site. The housewife can find her children at a busy shopping center. The motorist can signal for help in an emergency. The salesman, the construction foreman, the traveler, the sportsman, the hobbyist–everybody can use the PocketCom.

LONG RANGE COMMUNICATIONS

The PocketCom's range is limited only by its 100 milliwatt power and the number of metal objects between units. Its power reaches from a few blocks in the city to several miles on a lake. Its receiver is so sensitve that signals sent from stronger citizen band stations several miles away can be picked up.

VERY SIMPLE OPERATION

To use the PocketCom, simply turn it on, extend the antenna, press a button to transmit, and release it to listen. And no FCC license is required to operate it. The PocketCom has two Channels–channel 14 and an optional second channel. Plug in one of the other 22 citizen band crystals, and slide the channel selector to the second position. Crystals for the second channel cost $7.95 and can only be ordered after receipt of your unit.



The PocketCom components are equivalent to 112 transistors whereas most comparable units contain only twelve.

A MAJOR BREAKTHROUGH

The PocketCom's small size results from a breakthrough in the solid-state device that made the pocket calculator a reality. Scientists took 112 transistors, integrated them on a micro-silicon wafer, and produced the world's first transceiver linear integrated circuit. This major breakthrough not only reduced the size of radio components but improved their dependability and performance.

BEEP-TONE PAGING SYSTEM

You can page another PocketCom user, within close range, by simply pressing the PocketCom's call A beep tone sounds on the other unit if it has been left in the standby mode. In the standby mode, the unit is silent and can be kept on for weeks without draining the batteries.

SUPERIOR FEATURES

Just check the advanced features now possible because of this new circuit breakthrough: 1) Incoming signals are amplified several million times compared to only 100,000 times on comparable conventional systems. 2) Even with a 60 decibel difference in signal strength, the unit's automatic gain control will bring up each incoming signal to a maximum uniform level. 3) A high squelch sensitivity (0.7 microvolts) permits noiseless operation without squelching weak signals.

EXTRA LONG BATTERY LIFE

The PocketCom has a light-emitting diode low-battery indicator that tells you when your 'N' cell batteries require replacement. The integrated circuit requires such low power that the two batteries, with average use, will last weeks without running down.

The PocketCom can be used as a pager, an intercom, a telephone or even a security device.

MULTIPLEX INTERCOM

Many businesses can use the PocketCom as a multiplex intercom. Each employee carries a unit tuned to a different channel. A citizen band base station with 23 channels is used to page each PocketCom. The results: an inexpensive and flexible multiplex intercom system for large construction sites, factories, offices, or farms.

NATIONAL SERVICE

The PocketCom is manufactured exclusively for JS&A and is the unit currently used on the hit TV show, Charlie's Angels. JS&A is America's largest supplier of space-age products–further assurance that your modest investment is well protected. The PocketCom should give you years of trouble-free service. However, should service ever be required, simply slip your 5-ounce PocketCom into its handy mailer and send it to our prompt national service-by-mail center.

The PocketCom measures approximately ¾" x 1½" x 5½" and easily fits into your shirt pocket. The unit can be used as a personal communications link for business or pleasure.

GIVE IT A REAL WORKOUT

Remember the first time you saw a pocket calculator? It probably seemed unbelievable. The PocketCom may also seem unbelievable, so we give you the opportunity to personally examine one without obligation. Order only two units on a trial basis. Then really test them. Test the range, the sensitivity, the convenience. Test them under your everyday conditions, and compare the PocketCom with larger units.

After you are absolutely convinced that the PocketCom is indeed an advanced product breakthrough, order additional units, crystals, or accessories on a priority basis as one of our established customers. If, however, the PocketCom does not suit your particular requirements, then return your units within ten days after receipt for a prompt and courteous refund. You cannot lose. Here is your opportunity to test an advanced space-age product at absolutely no risk.

A COMPLETE PACKAGE

Each PocketCom comes complete with batteries, high-performance Channel 14 crystals, complete instructions, and a 90-day parts and labor warranty. Send **$19.95** per unit (or $39.90 for two) plus $2.50 per order for postage, insurance, and handling, (Illinois residents add 5% sales tax.) or credit card buyers may call our toll-free number. But don't delay.

Personal communications is the future of communications. Join the revolution. Order your PocketComs at no obligation today.

NEW LOW PRICE!

Credit Card Buyers Call Toll-Free

$19.95 per unit

*Sold originally for $40 per unit.

JS&A NATIONAL SALES GROUP ®

Dept. PE One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-9000

CALL TOLL-FREE.... 800 323-6400
In Illinois call .... (312) 498-6900

Letters

CHEERS FOR "EXPERIMENTER'S CORNER"

Until I read the February, March, November, and December 1977 "Experimenter's Corner," I was in the dark about the digital IC's discussed. Now, I see the light. Thanks POPULAR ELECTRONICS and Forrest Mims. Let's have more, more. *—C. Britton, Scarborough, Canada.*

INTERNATIONAL LAW ON LICENSING

I take exception to the comments made by Gil Duddles in the "Letters" column in the October 1977 issue. It is international law—not the choice of the American citizen—that gives hams license to operate on the airwaves. The US is just one of the hundreds of member countries of the International Telecommunications Union (ITU) that make up the rules and regulations by which radio operations are governed. The suggestion that a technically competent person who does not demonstrate ability in Morse Code should be given a license is covered by Article 41 Section 3 Paragraph 1 of the ITU regulations: "Any person operating the apparatus of an amateur station shall have proved that he is able to send correctly by hand and to receive correctly by ear texts in Morse code signals. Administrations may, however, waive this requirement for stations making use exclusively of frequencies above 144 MHz."

Again quoting from the ITU regulations, Article 41 Section 3 Paragraph 2: "Administrations shall take measures as they judge necessary to verify the technical qualifications of any person operating the apparatus of an amateur station."

So according to the ITU, an applicant for an amateur license must prove technical competence *and* ability to send and receive code before a license can be granted. *—Dr. Jerrold L. Patz, K1PKT, Wrentham, MA.*

LIKES SWL ARTICLES

I was very pleased to discover the SWL features in the November 1977 issue of POPULAR ELECTRONICS. Mr. Woods' SWL schedules are accurate and extremely useful. Mr. Hauser's article is also most interesting. It is gratifying to see the emphasis placed on the program material instead of the search for rare DX. *—Arthur Crookshank, New York, NY*

ELF ADDITIONS

I would like to add my name to what I am sure is a long list of satisfied subscribers who have built the "COSMAC Elf Microcomputer" (August 1976). Being an experimenter, I would like to show off my addition to the original Elf. The photos shown here are representative programs that demonstrate my 32-character oscilloscope display. The circuit I am using for this display is an adaptation of the "Scopewriter" featured in the August 1974 issue of POPULAR ELECTRONICS.

Photo 1 is self-explanatory. An ASCII keyboard was the input device for this line write/edit program. Photo 2 is the word guessing game "Hangman" in progress. The secret word is "COSMAC," the player has de-

pressed "G," which is incorrect, and another letter has been added to HANGMAN. Photo 3 illustrates what I call a memory-map program. The eight bytes represent what is in memory, starting at the displayed address. This program allows inspection and correction of any part of memory. *—Lynn R. Clock, Lompoc, CA.*

RADAR DETECTOR ADVOCATE

I was quite distressed to read your Editorial comments in the November 1977 issue of POPULAR ELECTRONICS. There is one important point that you didn't mention, legally referred to as probable cause. Your home cannot be searched or your telephone tapped without a search warrant. A warrant is issued only if the police can show probeble cause that a crime has been committed. When a "Smokey" is beaming his MR7 moving radar at you on the road with it on all the time and does not wait for probable cause, he technically violates your right to privacy.

As used by most states, radar is for revenue purposes. The 55-mph law has not been effective in saving lives or resources, a fact documented by the Comptroller of the United States and various state agencies. If our police were instructed to go hard on drunk drivers who account for 40% of all fatal accidents, reckless drivers, and "junk" cars, the roads would be safer, especially with a return to previous speed limits. *—Bence D. Boelcskevy, Vice President, BMW Car Club of America, Inc., Cambridge, MA*

New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Reader Service Card inside the back cover or write to the manufacturer at the address given.

Aiwa Stereo Cassette Deck

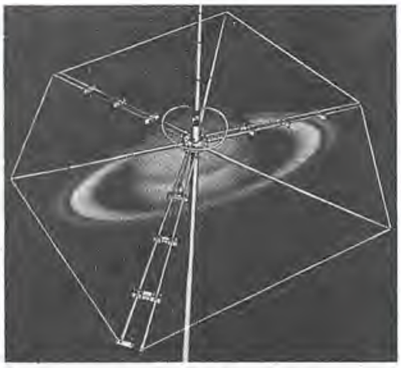
Aiwa has developed a mechanism that measures the reel rotation speed of the cassette and displays the remaining time for the tape. This device is incorporated into the company's Model AD-6550 stereo

cassette deck with built-in Dolby noise-reduction system. The time is shown in minutes to the left of the meters. The deck's ratings include a wow and flutter of 0.05% weighted rms and a S/N ratio of 65 dB. Its specified frequency responses are: 30 to 13,000 Hz for LH and 30 to 15,000 Hz for CrO_2 and FeCr tape. A bias fine adjustor is provided for LH/normal tape. A two-step peak-indicating LED system is designed to activate at +3 and +7 dB. Additionally, there is a memory rewind system. $450.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Avanti CB Base-Station Antenna

The Avanti Saturn CB base-station antenna is a coinductive system that combines four antennas that operate on two polarities in what is claimed to be the most unique antenna yet devised. The vertical radiator section is 22' (6.7 m) in height, giving it the desirable radiation of a ⅝-wave design. While using vertical polarity, the horizontal section automatically serves as a ground plane for the radiator. The horizontal section consists of three half-wave dipoles that are electronically co-phased to



yield an omni-directional radiation pattern. The feed system is arranged so that equal power is applied to each dipole, via separate multipurpose balun coils. The method by which the power is equally divided and transferred to the dipole radiators is the heart of the Saturn's design.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Ballantine 80-MHz Frequency Counter

Ballantine's Model 5720A frequency counter covers a direct-count range of 10 Hz to more than 80 MHz. It features an audio tone multiplier circuit that provides a claimed resolution of 0.01 Hz in only a 1-second measurement time. Frequency and ratio measurements are read out from an eight-digit jumbo LED display. Direct readings are in megahertz, kilohertz, or

hertz as selected by a front-panel switch. The POWER and range switches are the only controls required for operation of the counter. The instrument's 1-megohm input impedance is shunted by 25 pF of capacitance. The input is fully protected against over-voltage to 250 volts rms from 10 to 1000 Hz, decreasing to 10 volts rms beyond 10 MHz. Sensitivity over the entire range is specified at 50 mV. $195.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Dual Direct-Drive Turntable

Dual's Model 604 semiautomatic turntable is direct-driven by a dc electronic motor whose speed is electronically regulated by a digital reference circuit. The tonearm is mounted in a four-point gyroscopic-type gimbal suspension. Two mechanical anti-resonance filters are housed in the counterbalance to attenuate acoustic feedback and parasitic resonances. The straight-line tubular tonearm offers what is claimed to be maximum rigidity with minimum mass. Other featuras include: mechanical sensor to locate lead-in grooves on 12" and 7" (30.5 and 17.8 cm) discs; damped cueing system; automatic tonearm return and

shutoff at end of play; 10% pitch control and illuminated strobe; and die-cast platter. Rumble is rated at greater than 70 dB and wow and flutter at less than 0.03%. Supplied with low-profile base and dust cover. $250.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Philips Portable Oscilloscope

A portable 15-MHz/2-mV oscilloscope, designated the Model PM 3211, is available from Philips Test & Measuring Instruments, Inc. The scope features comprehensive display and triggering facilities and a double-insulated power supply that requires no grounding to eliminate hum and spurious signals. Triggering can be in AUTO or level set and multi-sourced, eliminating the need to change probes. Channel B can be used as an X input to facilitate

X-Y displays with calibrated attenuation of both X and Y inputs. It can also be inverted and, with the scope's ADD function, can display A ± B. An 18-speed timebase has a vernier control for simplified phase and timing measurements. $875, including two probes.

CIRCLE NO. 96 ON FREE INFORMATION CARD

Genesis Speaker System

The Model 3 speaker system from Genesis Physics Corp. employs three specialized drivers, each of which is claimed to be engineered for extremely long linear excursion relative to cone size. This approach is said to provide the large power handling capability of larger-diamater drivers with the sonic superiority of small, lightweight drivers with respect to transient response, suppression of resonance distortion and

coloration, and full frequency dispersion. A passive radiator extends the system's low-frequency limits. The midrange driver is housed in an acoustically isolated enclosure, and the tweeter is damped by a viscous magnetic ferrofluid. A specially designed crossover network is said to preserve a high degree of phase integrity. $299.50.

CIRCLE NO. 97 ON FREE INFORMATION CARD

SJE Morse Code Typewriter

S.J. Engineering's Model SMCT simulated Morse-code typewriter lets an aspiring ham radio operator learn and send Morse code simply by touching a built-in probe to selected letters and numerals. Once a character is touched with the probe, the typewriter self-produces and completes the equivalent Morse-code output for that character. Speed is adjustable from 5 to 60 wpm. Also adjustable are the volume level and tone. The typewriter features two outputs: audio for learn/practice and reed relay for making on-the-air contacts. Power for the CMOS circuitry is from two 9-volt batteries (not supplied). $99.95, wired and tested; $69.95, kit.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Heath Electronic Cruise Control

According to the Heath Company, its new Model CS-1048 electronic cruise control

can provide increased fuel mileage and promote driving safety by reducing fatigue on long trips. The device is completely electronically controlled. Accuracy is reported to be within 2 mph of the preset speed regardless of load and other variables. A "resume" memory holds the preset speed. In addition, the cruise control is said to be capable of operation with both manual and automatic transmissions. It can also be removed from one vehicle and reinstalled in another vehicle with a minimum of changes. The device comes assembled, ready for installation in vehicles having open driveshafts, as most cars do. Catalog price is $79.95.

CIRCLE NO. 90 ON FREE INFORMATION CARD

Pioneer AM/Stereo FM Receiver

The Model SX-1280 AM/stereo FM receiver from Pioneer is rated at 185 watts/channel minimum into 8 ohms from 20 to 20,000 Hz at no more than 0.03% THD. Its power amplifier section employs a direct-coupled OCL design, while separate power supplies are used for the two channels. The AM/FM tuner uses a MOSFET in the r-f mixing stage and a JFET in the mixing buffer stage. FM sensitivity is 9.8 dBf; capture ratio, 1.0 dB. Two of the four meters in the receiver are used for indicating power, separately for each channel. They respond to output powers from 0.01 to 370 watts without requiring sensitivity switching. The volume control is a 32-step attenuator type. Built-in are high and low filters, audible multipath switch, 25-µs FM deemphasis switch, stereo adapter in/out terminals and switch. $900.

CIRCLE NO. 99 ON FREE INFORMATION CARD

CPI AM/SSB CB Base Station

The Ultra CP-2000B "limited-edition" CB base station from Communications Power, Inc., employs a modulator that is said to provide an unusually high level of modulation without exceeding FCC specifications. Spurious response is rated at −70 dB. The transmitter is said to have an infinite SWR mismatch tolerance. Specifications for the single-conversion receiver include −70 dB i-f rejection, −80 dB adjacent-channel rejection, and −85 dB intermodulation characteristics. Built in are a switchable speech

compressor, switchable anl/noise blanker, r-f gain control with automatic override, and microphone gain control. Separate r-f output power/S and SWR calibration meters are provided. An optional Model BC-2000 base-station console provides: 7-digit frequency counter; 6-digit 12/24-hour clock; FET receive preamplifier; dual antenna tuner; dual antenna switch; and −50-dB TVI filter. $600.

CIRCLE NO. 100 ON FREE INFORMATION CARD

MORE than just a base station!

The New Realistic CB-Fone Communications Console

Realistic® invents the base CB that's also a control center. Perfect for home, office, small warehouse or dispatcher-type operations. The push-to-talk phone-type handset is great for private listening or noisy areas. Add a remote speaker — the CB-Fone becomes a paging/PA amplifier that lets you monitor incoming CB calls simultaneously. Emergency? Push the red priority button and you're instantly on Channel 9. Channel selection is electronic. Two buttons — count-up and count-down — replace rotary switches. Push once to change channels, hold down for rapid movement through all 40 channels. Big LED readout displays the channel number and indicates "PA" in public address mode. Flip-switches for delta-tune, blanker, handset or handset-plus-console speakers, mode selection. RF gain control. Lighted SWR and S/RF meters. On-the-air and modulation lights. AC and 12VDC versatility, positive or negative ground. U.L. listed. The CB-Fone — just 249.95* buys you a station that's something else!

These two credit cards honored at most Radio Shack stores.
*Price may vary at individual stores and dealers.

Radio Shack®

A DIVISION OF TANDY CORPORATION • FORT WORTH, TEXAS 76102
OVER 6000 LOCATIONS IN NINE COUNTRIES

New Literature

TELEX CB MIKE BOOKLET

"The CB Power Mike Fact Book" explains and discusses basic points and facts regarding CB power microphones. One important feature discussed is how a CB noise-cancelling mike keeps unwanted sound out. Other basic points covered include "Why the Microphone is a Most Important Part of Your Transmitter"; "Will a Power Mike Work With My 40 Channel Radio?"; and "The Special Advantages of CB Power Mike Headsets." The booklet, with drawings and photos, may be obtained by writing to Telex Communications, Inc., 9600 Aldrich Avenue South, Minneapolis, MN 55420.

JENSEN TOOL CATALOG

A new 144-page catalog of tools for electronic and mechanical assembly is offered by Jensen Tools and Alloys. It includes over 3,000 tools in categories such as micro-tools, test equipment, soldering equipment, tweezers, screwdrivers, cutters, drafting supplies, and power tools. Another section features tool kits and cases. Address: Jensen Tools and Alloys, 1230 South Priest Drive, Tempe, AZ 85281.

SIGNAL TRANSFORMER CATALOG

"Transformers," a 16-page publication from Signal Transformer Co., Inc., combines a short-form catalog and an application guide. It presents specifications and mechanical data on the company's line of transformers. Schematics are included. Among the components featured are the conventional power transformers, filter chokes, rectifier, high-current, step-down auto, step-up or step-down power-isolation transformers and low-cost Split/Tran[R] and Flathead[R] printed-circuit board transformers. Address: Signal Transformer Co., Inc., 500 Bayview Ave, Inwood, NY 11696.

MOTOROLA TWO-WAY RADIO TEST EQUIPMENT CATALOG

Thirty-one additions to Motorola's line of two-way radio test equipment appear in the company's new catalog. Featured are the models R-1200A service monitor, R-1010A signal generator, and S-1338A FM station monitor. Other test instruments for the maintenance of FM two-way radio communications equipment are included. Address: Motorola Literature Distribution Center, 1301 E. Algonquin Road, Schaumburg, IL 60196.

NATIONAL SEMICONDUCTOR LED CATALOG

National Semiconductor has prepared a catalog describing its line of opto-electronic products. The catalog contains photographs, outline drawings, and specifications of red, yellow and green light emitting diode (LED) lamps, multi-digit numeric displays, small calculator-type numeric arrays and watch display die. An application section is included on mounting techniques for numeric displays. The catalog also contains a list of National's LED segment drivers and digit drivers, with specifications and ratings. Address: National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, CA 95051.

MALLORY GENERAL CATALOG

A new general catalog lists over 8,000 electronic components and related products made by P.R. Mallory & Co., Inc. Information on lines of capacitors, controls, switches, semiconductors, audible signal devices, security products, and cassette recording tape is provided. Address: Mallory Distributor Products Co., Box 1284, Indianapolis, IN 46206.

OEI COMPONENT CATALOG

The 1978 catalog of Optical Electronics, Inc., contains 41 data sheets on 18 operational amplifiers, 22 fast analog function modules, and a microcomputer. A selection guide indexes op amp modules by slewing rate, by gain-bandwidth at X100, and by settling time to 0.1%. The selection guide for function modules is arranged by model number and function: logarithmic amplifiers, sample and hold, peak sense and hold, V-F-V, D-A-D, power supplies and others. Address: Optical Electronics, Inc., Box 11140, Tucson, AR 85734.

AUDIO-TECHNICA MICROPHONE GUIDE

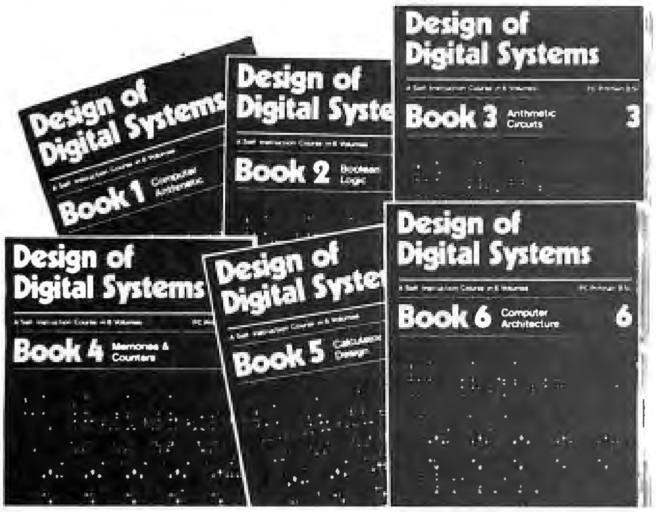
Available from Audio-Technica, "A Brief Guide to Microphones," is an instructional booklet applicable to all brands of microphones. The 15-page publication explains microphones through 8 basic terms: dynamic, condenser, omnidirectional, unidirectional (or cardioid), proximity effect, feedback, impedance and sensitivity. Address: Audio-Technica U.S., Inc., 33 Shiawassee Ave., Fairlawn, OH 44313.

INTERFERENCE INFORMATION

Interference and power-line surge damage common to audio equipment and FM receivers are described in a new flyer from Electronic Specialists. Problems such as lightning protection, ac power-line hash, and loudspeaker interference pickup are included. Cures for these problems are offered. Address: Electronic Specialists, Box 122, Natick, MA 01760.

Understanding Digital Electronics

New teach-yourself courses



Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each 11-1/2" x 8-1/4" are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

The contents of Design of Digital Systems include:

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.
Book 2 OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.

Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes — each 11-1/2" x 8-1/4" — and serves as an introduction to the subject of digital electronics. Everyone can learn from it — designer, executive, scientist, student, engineer.

Contents include: Binary, octal and decimal number systems; conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops; binary counters, shift registers and half adders.

In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your automobile speed and gas consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. Learning by self-instruction has the advantages of being faster and more thorough than classroom learning. You work at your own pace and must respond by answering questions on each new piece of information before proceeding.

After completing these courses you will have broadened your career prospects and increased your fundamental understanding of the rapidly changing technological world around you.

The six volumes of Design of Digital Systems cost only: **$19.88**

And the four volumes of Digital Computer Logic and Electronics cost only: **$14.88**

But if you buy both courses, the total cost is only: **$29.90**

a saving of over: **$5.00**

SEVEN-DAY MONEY-BACK GUARANTEE: If you are not satisfied with your Cambridge course, return it within 7 days for a full refund.

To order your books, complete the order form below and send it together with your check or money order to GFN Industries, Inc., 6 Commercial Street, Hicksville, N.Y. 11801.

To: GFN INDUSTRIES, INC.
6 COMMERCIAL STREET, HICKSVILLE, NY 11801

Please send me:

___ Sets of Design of Digital Systems $19.88 ______
___ Sets of Digital Computer Logic & Electronics $14.88 ______
___ Sets of both courses $29.90 ______
Sales tax (N.Y. residents) ______
Shipping and handling $2.50 per set ______

Enclosed is check/mo (payable to GFN Industries, Inc.)

Total $______

Name ______

Address ______

City/State/Zip ______

Prices include overseas surface mail postage. PE4B

Stereo Scene

By Ralph Hodges

WITH THE HIGH ROLLERS IN VEGAS

FOR SOME TIME, the Winter Consumer Electronics Show (WCES) has been overshadowed by its much larger summertime brother. If this past January's installment was any different, it is probably because a change of venue from frigid Chicago to the comparatively benign climate of Las Vegas piqued enthusiasm, curiosity, and deeply harbored desires for a brief vacation after a grueling Christmas. It did not seem like much of a vacation from this side of the footlights, however.

The new WCES (it will return to Las Vegas next year) proved considerably enlarged in attendance and square yardage, particularly since it sprawled well beyond the official Convention Center headquarters and into a host of neighboring hotels and motels in true summer CES fashion. This raised certain tactical problems. For security reasons, the hotels refused to divulge room numbers, so that my search for some exhibitors simply had to be abandoned for lack of sufficient time or a competent wilderness guide. Next year I shall be more familiar with the territory.

As usual, the show offered no challenge to its summer counterpart in sheer numbers of new audio product introductions, but several of the debuts that did take place were provocative. A sampling follows.

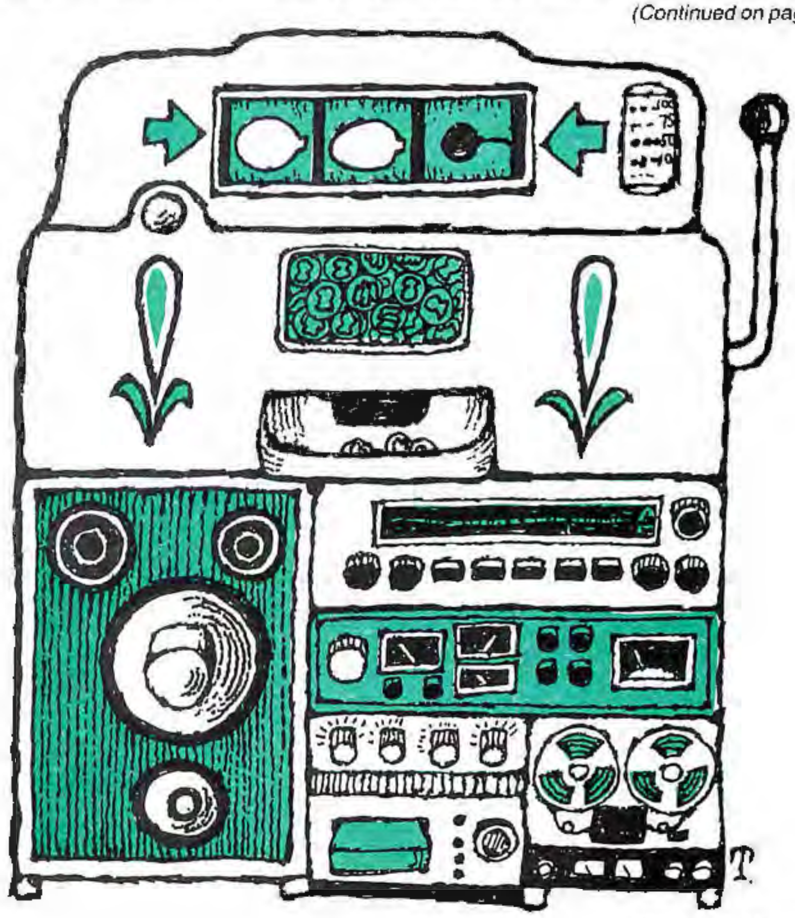
Musclemen. Thanks to Pioneer's new SX-1980, receivers are now up to 270 watts per channel and very probably still climbing. Happily, the newer super receivers are not growing much in size over the largest models of yesteryear. Instead, the problems involved with cooling units of this capacity are being solved on the engineering level. Pioneer's solution is a power transistor with a new body style that makes more surface area available to contact the heat sink. Combined with an internal "chimney" that encourages efficient flow-through of air, the transistors evidently can throw off heat rapidly enough to obviate the need for forced-air cooling– an impressive achievement at a time when pundits have only half-humorously predicted that the helium-cooled receiver is just around the corner. Clearly, the super-power receiver is well on its way to becoming commonplace. Even Sanyo, a company heretofore associated with middle-fi equipment and clock radios, has broken new ground with the 120-watt-per-channel JCX2900K.

In another accelerating trend, receivers, having been threatened somewhat by the growing popularity of separates, are now in the process of becoming separates themselves. Rotel introduced a receiver with a "docking" power-amplifier section a year or so ago, and Mitsubishi applied the same concept to an integrated amplifier. At WCES, Sansui joined in with the G22000, the top model of the G Series at 220 watts per channel. The forerunners of the G Series appeared at last June's show, and this new addition continues the interesting styling that distinguishes the line.

Many of the new amplifier introductions clustered around the mid-power level, an example being the Marantz 300DC power amplifier at 150 watts per channel. The Marantz unit is also indicative of a growing concern about slew rate and transient intermodulation distortion; the manufacturer lays heavy emphasis on the efforts made to control these performance parameters. Besides being augmented by a new 500-watt-per channel (!) stereo power amplifier (the Dual 500) and an analog time-delay/reverberation unit (Model 6000), the Phase Linear line has been completely restyled. The restyling included circuit modifications to virtually all the existing Phase Linear models, with FET inputs being much in evidence.

Hitachi has employed MOSFET output devices in two new power amplifiers, the HMA 7500 and HMA 9500, with 75 and 100 watts per channel, respectively. The $500 price of the HMA 7500 would appear to be a bargain for FET amplifiers. The company also introduced a matching preamplifier, two new three-

(Continued on page 20)



The 1980 Kenwoods.

No. We're not kidding. By 1980, the kind of performance these new Kenwoods deliver will be considered commonplace. Here's a summary:

1. The KA-7100 is an integrated DC amplifier with dual power supplies delivering 60 watts per channel, minimum RMS at 8 ohms from 20-20k Hz, with no more than 0.02% total harmonic distortion. Not only is that the lowest THD of *any* integrated amp, the KA-7100 is the lowest priced DC integrated amp on the market. ($300*)

2. The KT-7500 marks the next plateau for FM tuners. For optimum reception under any condition it has two independent IF bands: the narrow band virtually eliminating interference when stations are close together, the wide band for lower distortion and maximizing stereo separation. In addition, we've developed new circuitry which eliminates the high frequency beat distortion (that is, swishing noises) thought to be inherent in stereo FM broadcast. Even we're impressed that it costs only $275*

This combination of separate amp and tuner not only gives you performance unheard of in other separate components, it gives you performance that will remain elusive in receivers for quite a while.

The Kenwood KA-7100 and KT-7500. Solid evidence that the breakthroughs occurred ahead of schedule, and available to you now for a truly remarkable price. $575* for the pair.

*Nationally advertised value. Actual prices are established by Kenwood dealers. Handles optional.

KENWOOD

For the Kenwood Dealer nearest you, see your Yellow Pages, or write Kenwood, 15777 S. Broadway, Gardena, CA 90248

25 million reasons into NRI training in CB and

The CB boom means big opportunities for qualified technicians... learn at home in your spare time.

There are more than 25 million CB radios out there, millions more two-way radios, walkie-talkies, and other communications apparatus in use by business and industry, government, police and fire departments. And all of this equipment demands qualified technicians to maintain and repair it. In addition to knowing what you're doing, you must have an FCC Radiotelephone License to service most of it. NRI can help you get both... the training and the license.

Learn on your own 2-meter, digitally synthesized VHF transceiver or 40-channel CB.

With NRI, you learn by doing. You use the NRI Discovery Lab™ to build and test a whole series of typical communications circuits, even assemble

Some designed-for-learning equipment you get

your own professional transistorized volt-ohm meter and a CMOS digital frequency counter. You test various types of antennas to gain a firm understanding of broadcasting principles. And finally, you assemble your own 2-meter transceiver for experiments in troubleshooting and servicing. Then, if you want to go on the air, we'll help you get your amateur license. As an alternate choice, you may elect to receive and experiment with a 40-channel CB to get more experience in this booming area.

™Trademark McGraw-Hill

You learn in your own home, in your spare time, at your convenience. NRI's bite-size lessons and carefully matched practical experiments combine theory and bench work to give you the most effective training for your money. No need to quit your job or take night classes, you move ahead at the pace that suits you best.

NRI guarantees your FCC license.

The law requires that technicians hold an FCC Radiotelephone License to work on broadcast equipment. NRI training in Complete Communications Electronics or our CB Radio Specialist course is carefully designed to give you the special coaching so helpful in passing FCC license exams. If you fail to pass the FCC examination for radiotelephone license after graduating, *NRI will refund your tuition in full.* The money-back agreement is valid for six months after completion of your course.

Send for free catalog. No salesman will call.

Find out all the facts about NRI's Communications or CB course. Or look into other areas of opportunity like TV and audio servicing, digital computer electronics, mobile communications, and more. Mail the postage-paid card today... there are more than 25 million good reasons why.

why you should look Communications Servicing.

Or get into TV and audio servicing

NRI can train you at home to service TV equipment and audio systems. Choose from five courses that go up to our 48-lesson Master Color TV/Audio Course. With it you get 14 kits for practical bench training and demonstrations, including NRI's exclusive, designed-for-learning, 25" diagonal solid state color TV, 4-channel audio system complete with speakers, and professional instruments you build and use for learning and earning. It's proven, effective training that's helped thousands of pros already. And it's the best value offered in the field. NRI's bite-size lessons speed learning, exclusive

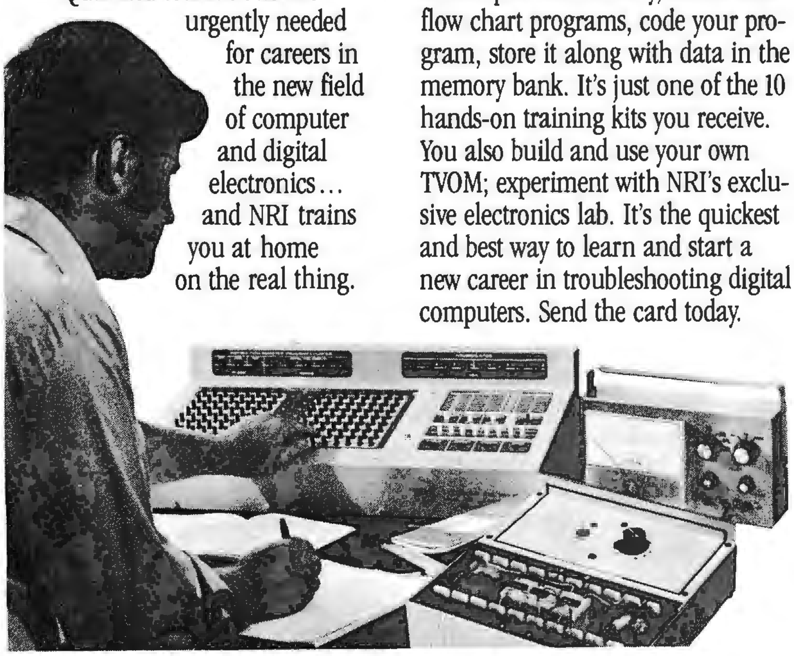
"Power-On" training makes it real. Send card for free catalog.

Learn computer electronics

NRI trains you at home on a real digital computer.

Qualified technicians are urgently needed for careers in the new field of computer and digital electronics... and NRI trains you at home on the real thing.

As part of your training, you actually assemble a working digital computer with expanded memory, define and flow chart programs, code your program, store it along with data in the memory bank. It's just one of the 10 hands-on training kits you receive. You also build and use your own TVOM; experiment with NRI's exclusive electronics lab. It's the quickest and best way to learn and start a new career in troubleshooting digital computers. Send the card today.



NRI instructor/engineers

Each NRI student is assigned his own course instructor. He's there to help you over any rough spots, explain problems, and give you the advice you need as you progress toward your future. And he knows what he's talking about, because he was more than likely involved in the design of your course or some of the NRI equipment you use. NRI instructors are practical, experienced people who really know their field and do their best to pass their knowledge on to you.

You get more for your money from NRI.

NRI employs no salesmen, pays no commissions. We pass the savings on to you in reduced tuition, top-quality professional equipment, and reliable testing instruments necessary for a successful career. You can pay hundreds of dollars more at other schools, but you can't get better training.

Free catalog, no salesman will call.

Get your free catalog and discover why NRI is the leader in home technical training with over a million students, over 60 years experience in helping people build new careers. Mail the card today and get started on your new future. If card has been removed, write to:

NRI McGraw Hill

NRI SCHOOLS
McGraw Hill Center
for Continuing Education
3939 Wisconsin Avenue
Washington, D.C. 20016

(Continued from page 14)
head cassette decks, and a novel direct-drive turntable. Sony's pulse-width modulation amplifier has now been designated the TA-N88 and is rated at 160 watts per channel. And among SAE's new introductions is a combined integrated amplifier and parametric equalizer, the Model 2922.

Loudspeakers. Helium-cooled amplifiers we may not have, but helium-cooled speakers may finally be here. A company called Plasmatronics exhibited a mid- and high-frequency driver consisting of a small quartz cell with a small square opening in its frontal surface. A continuous stream of helium is bled into the cell in the presence of a high polarizing voltage. An eery violet glow with tinges of green and yellow promptly appears; and when an audio signal is applied (from an internal vacuum-tube amplifier), what comes out is sound.

The designer, Alan Hill, is not yet able to be totally specific about the operating principle (patent considerations are involved, I imagine); but this is clearly an ionized-gas loudspeaker with an unusually wide frequency response (down to 700 Hz) and dynamic range. Speculation about the purpose of the helium continues. Some believe that it assists in high-frequency propagation (ever heard a man speaking in a helium-oxygen atmosphere?) while others suspect it is merely a coolant (the cell radiates an impressive amount of heat). In any case, a tank of the gas lasts an estimated 300 hours, after which you must return for a refill. The Plasmatronics speaker has a conventional dynamic woofer and some very impressive frequency-response and impulse-response specifications. The associated preamplifier offered by the company is highly recommended; it has a switch to halt the helium flow.

Acoustic Research has a new top-of-the-line model, the AR9, standing over 4 feet tall and equipped with dual side-firing woofers (12 inches each) placed for optimum acoustic coupling with the nearest room boundaries. It is a four-way design with what AR says is the flattest response and highest power-handling capability it has ever achieved.

Infinity's latest speaker system, the Quantum Reference Standard, is likewise a top-of-the-line model, offered on a custom-order basis at a projected price of $6500 the pair. They make use of vertical arrays of the EMIT film-diaphragm tweeters, to which the manufacturer is now fully committed; and they have a multi-faceted cabinet that is certainly one of the largest ever introduced to the consumer market.

JBL's new products consisted of the L50, the lowest-price three-way design in the JBL catalog, while KLH launched several additions to its Baron series. In addition, ESS presented quite a few modifications to many of its existing products and unveiled a production-ready version of the Transar loudspeaker with the unique Heil woofer.

And Elsewhere. Kenwood's new top-of-the-line turntable, the KD-750, follows a number of acclaimed successes in turntable design by that manufacturer, and also incorporates a 20-pole dc motor. (Multi-element motors are becoming increasingly favored by designers of direct-drive systems as the fight to eliminate any trace of cogging continues.) The Harman-Kardon/Rabco ST-8 is a thoughtful redesign of the ST-7, using the same radial tracking principle but benefitting from various refinements. AR has a rather special turntable in the works as well, but in the meantime the company offers the AR77-XB, the latest evolution of its classic AR turntable.

Listeners to older 78-rpm records—which in many cases were not quite 78 rpm—have long bemoaned the lack of turntables that are continuously variable in speed. They will be glad to learn that the elusive Lenco record players are now back and firmly entrenched with Neosonic Corporation of America acting as importer and distributor. The three Lenco variable-speed models operate at anything from 30 to 86 rpm, and can be bought with and without bases.

Turntables, tuners, and cassette decks are the areas in which automation and computer techniques have found their happiest consumer application so far, and this tradition continues with a new cassette deck from Sharp/Optonica. Incorporating all of the program-search features of previous models from this manufacturer, the new machine also has a liquid-crystal display that indicates the operating function and the time of day, as determined by a 24-hour quartz-crystal clock with a seven-segment digital readout. Perhaps needless to say, the clock also functions as a timer. Therefore, the deck can be set to record any program at any time and then turn itself off, all without any operator's attention.

Another interesting cassette development is the re-emergence, of the cassette changer/player. Lenco's RAC-10 machine, capable of handling up to ten cassettes at a time, has returned to the U.S. It is not a device for everyone, but it appears to be the single survivor of a possible trend that showed promise some years ago.

Accessories is a product category that has grown from an afterthought to a major center of consumer attention, and few accessories were as popular at this show as racks—equipment-holding racks, that is. Kenwood, Sansui, Mitsubishi, and Harman-Kardon are a few of the major companies that have followed the lead of Pioneer and Nakamichi in introducing vertically tiered equipment cabinets, some with casters, that will readily accept the 19-inch front panels of much current equipment. Whether they will accept the varying depths and heights of different manufacturers' amplifiers, preamplifiers, and tuners is still an unanswered question, as are such matters as ventilation and provision for interconnecting cables. Optonica showed a variety of other types of cabinets to house hi-fi components. They feature push-to-open glass doors for the LP record storing section.

In the meantime, record-care accessories are proliferating beyond any hope of keeping track of all of them; even tape companies like Memorex have devised extensive lines of stylus-force gauges, record-tracking dust removers, and hand-held record decontaminators. So far, none of these new products conspicuously demonstrates any new thinking about the problem of dirt on record surfaces, but neither does any of them seem ill-suited to its purpose.

Many are calling the new ADS 10 Acoustic Dimension Synthesizer the best of the available reverberation devices for the home user. It is an entirely digital processor with a frequency response (at −20 dB) of 30 to 13,000 Hz and a continuously variable decay time of up to 1.6 seconds. ADS has built in a 100-watt-per-channel stereo amplifier, and includes a pair of L10 speaker systems for rear-channel use with the package. The operation of the A-to-D/D-to-A converter is still classified, but it was revealed that a special circuit is built-in to limit the reverberation enhancement afforded to mono signals when desired. Consequently, FM programs can be listened to without the announcer sounding as if he were speaking from a cathedral floor.

All of these products should be getting some attention in these pages in months to come. And from first appearances, they will deserve it. ◇

Para-Power

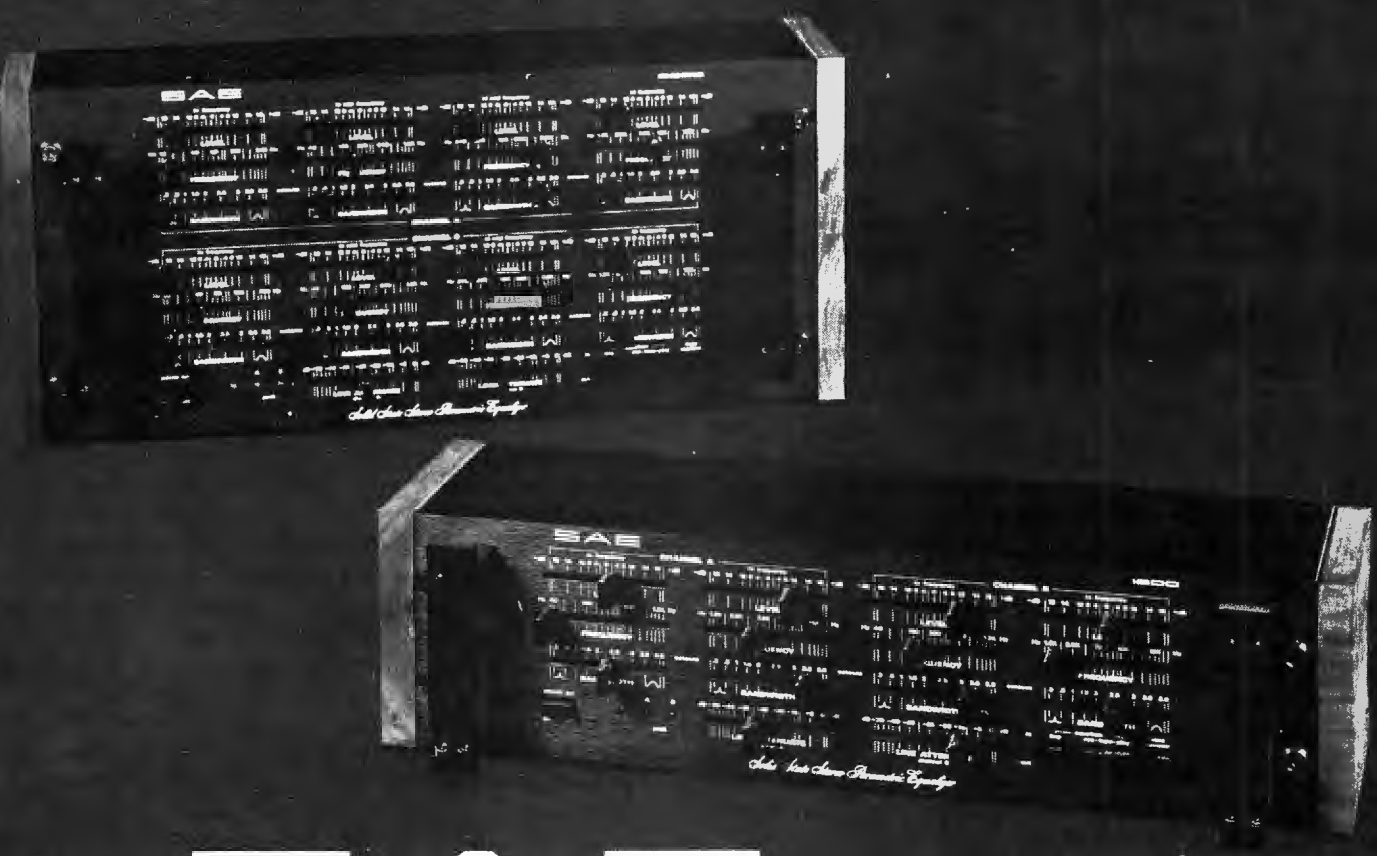
(Parametric Equalizers by SAE)

SAE has long been involved in the field of tone equalization. From our pioneering efforts in variable turn over tone controls to our more recent advancements in graphic equalizers, we have continually searched for and developed more flexible and responsive tone networks. From these efforts comes a new powerful tool in tone equalization – the Parametric Equalizer. Now you have the power of precise control.

Our 2800 Dual Four-Band and 1800 Dual Two-Band Parametrics offer you controls that not only cut and boost, but also vary the bandwidth and tune the center frequency of any segment of the audio range.

With this unique flexibility, any problem can be overcome precisely, and any effect created precisely.

With either of these equalizers, you have the power to correct any listening environment or overcome any listening problems that you are faced with. Whether you need a third octave notch filter, tailored bandwidth to resurrect a vocalist, or a tailored cut to bury an overbearing bass, the control flexibility of Parametric Equalizers can fill these needs and many more. And of course, as with all SAE products, they offer the highest in sonic performance and quality of construction.



only by SAE

Scientific Audio Electronics, Inc.
P.O. Box 60271 Terminal Annex, Los Angeles, CA 90060

CIRCLE NO. 57 ON FREE INFORMATION CARD

Julian Hirsch Audio Reports

HIRSCH/HOUCK LABORATORIES

THE POWER RACE—WHEN WILL IT END?

IT IS EASY to be carried away by the ever-increasing power ratings of today's receivers and amplifiers. Not long ago, a basic power amplifier that could deliver 100 watts/channel rated the name "super power." (Such power levels were unheard of in receivers.) Then amplifiers began to have ratings of 200 to 250 watts, and receivers crept up to 120, 150, 160, and 180 watts. Last year, the leader in the receiver power race was a giant from Marantz, rated at 250 watts/channel, but a 270-watt receiver from Pioneer now threatens its position. In basic power amplifiers, a 500-watt/channel Rotel amplifier currently leads the race, but similarly rated amplifiers from Phase Linear and possibly others are in the offing. Apparently the end of the race is not yet in sight.

The justification for this race to greater and greater power is multifaceted. Partly, it is merely because technology now makes it possible, at reasonable cost, to generate such huge power outputs. Some of today's power transistors can dissipate hundreds of watts per device, yet are priced low enough for use in consumer products. Manufacturers can hardly be blamed for attempting to convert some of this new technology into saleable hardware. And the prices of some of these products are not unreasonable in view of their performance, though some may find the size and weight excessive for their homes.

Another side to the question of "how much power" is one of need, or at least, utility. No one will claim that a power level of hundreds of watts per channel is always necessary for good reproduction. However, there are convincing arguments that prodigious power can be used to advantage under some circumstances. If it can be utilized and if it can be generated without prohibitive expense, why not have it available in our deluxe amplifiers and receivers?

One of the two questions most often posed to me is what amount of power is needed for a good hi-fi system? Even after I narrow down the scope of the question by establishing what type of speaker systems will be used in what size room, etc., the answer is still necessarily vague and unsatisfying. What it boils down to is that you need as much power as is necessary to play music as loud as you like to hear it. While this is the literal truth, it is of little help in selecting system components. Under most home conditions, reasonably high acoustic levels can be generated with only 1 or 2 watts of amplifier power. It is, therefore, difficult for a layman, or even an experienced audiophile, to understand how a reserve of hundreds of watts can be beneficial or justifiable.

The explanation for this "need" for high power lies in two different, though related, aspects of sound. Most natural sounds, either music or speech, are nonsinusoidal. They consist of a multitude of frequencies whose combined waveform usually has a high crest factor. The maximum instantaneous peak amplitude is many times the rms value of the waveform, computed through a complete cycle of its fundamental frequency. (In contrast, the instantaneous peak value of a sine wave is only 1.41 times its rms value.) The perceived loudness of a sound is roughly related to its average or rms value, the two usually being of the same order of magnitude. Brief peaks that exceed the rms level by a factor of 10 or 100 times are not heard as being louder. The effect is familiar to everyone who has heard the greatly increased apparent loudness of TV or radio commercials, as compared to the average program levels. The peak modulation levels are unchanged (any transmitted increase would result in illegal overmodulation), but the average level of the commercial is raised by compression so that it is heard at a much higher volume.

The second factor is the intermittent nature of music and speech. Regardless of the wave shape of the sound, it is characterized by large variations in level during the program. Musical passages may be very soft, or there may be periods of complete silence, followed by periods of very high program levels. The average level, over the entire duration of the program, is normally very much less than the maximum level attained during that interval. Thus, to reproduce either music or speech in a natural manner, the amplifier must have the capability of delivering peak outputs many times the average power.

The amount of reserve "headroom" needed in an amplifier varies widely with the program material, since all recorded and broadcast programs are limited to keep their peak levels within the limits set by the transmission medium. A headroom of only 10 dB may be adequate in many cases, but for most realistic reproduction, 20 dB is preferable.

The 20-dB headroom is a power ratio of 100 times. If the average power during a musical passage is

Test semiconductors without testing your patience.

The real value of using a semiconductor tester should be time savings. B&K-PRECISION semiconductor testers are designed for maximum speed and reliability to save you more time than any other testers.

B&K-PRECISION semiconductor testers are proved as highly cost effective answers to the needs of testing discrete semiconductor devices. Recently, they were evaluated by America's best known manufacturer of expensive test instruments and the $310 Model 530 compared favorably with a $30,000 custom test system! B&K-PRECISION has a model for most every application.

The B&K-PRECISION Model **530** is one of the most versatile semiconductor testers available and can actually perform more tests on more devices than any instrument in its price class. Features include: Exclusive patented f_T measurement circuit...Non-destructive breakdown voltage testing...Automatic lead and polarity identification, in- or out-of circuit...Measurement of beta and gm...Aural and visual test indications...Testing of new power FET's. CSA listed. **$310**

For value, the Model **520B** industrial semiconductor tester is tough to beat. Dynapeak™ circuitry with high/low drive allows the 520B to work in-circuit where others won't...A complete test takes about 9 seconds ...Identifies all leads of transistors and SCR's and polarity...CSA-listed version available..."Good device" indicated visually and aurally. **$175**

At only **$97**, the Model **510** offers Dynapeak™ test method reliability with pocket-size portability...LED test result indicators...Tests all types of transistors, FET's and SCR's...Digital stability never needs calibration...Complete with case and leads. **$97**

When applications demand analysis of the characteristic curves of semiconductor devices, the B&K-PRECISION Model **501A** is the cost-effective answer ...Displays characteristic curves for all semiconductor devices on most any scope...Non-destructive breakdown voltage tests...Simulates actual operating conditions...Internal calibration source...Current limiting protects device under test. **$198**

Start testing semiconductors faster now. See your local distributor for immediate delivery.

B+K PRECISION DYNASCAN CORPORATION

6460 W. Cortland Avenue, Chicago, IL 60635 312/889-9087

In Canada: Atlas Electronics, Ontario • International Sales: Empire Exporters, Inc., 270 Newtown Road, Plainview, L.I., NY 11803

CIRCLE NO. 9 ON FREE INFORMATION CARD

about 1 watt (it could range from a few milliwatts to several watts), the amplifier will be called upon to handle an occasional peak of as much as 100 watts. "Occasional" here means as infrequently as a few milliseconds out of a half hour of playing, or perhaps as often as 10% of the time, but more likely the former. If the amplifier cannot deliver those peaks, the result will be clipping, which may be audible.

Most of us manage to enjoy our music systems without undue distress from amplifier peak clipping, even with considerably less than 100 watts of power available to us. Recorded programs rarely have more than a 10-dB peak-to-average ratio, since they are designed for playback on mass-produced record players with very limited power capabilities. Some speaker systems are so efficient that they require only a tenth as much power as others for the same volume level.

With the foregoing in mind, why do we need "super-power" amplifiers, and what possible justification can there be for receivers or amplifiers that can deliver hundreds of watts per channel? The answer, or part of it, lies in the logarithmic nature of human hearing. To make a program sound twice as loud, we must increase the power ten-fold. Another doubling of apparent loudness, and we require 100 times the original average power level (and as much as 100 times *that* level to handle the peaks).

It might appear that there is no practical solution to the power "shortage." If our hypothetical 1-watt average program, heard at a comfortable level (and requiring from 10 to 100 watts of amplifier power in reserve just to avoid peak clipping) is to be played "just a little bit louder," we can easily find ourselves running out of power, even with a 200– or 300-watt amplifier. This is not as far-fetched as it may seem. I find it very easy to clip the outputs of an amplifier rated at 200 watts/channel or more, at levels far below those that exist at a discotheque or in the vicinity of a small instrumental combo when using speakers of average efficiency.

Not surprisingly, the equipment manufacturers' answer to the clipping problem is to make more powerful amplifiers. Unfortunately, this is no answer at all, since a 500-watt amplifier will play only a barely detectable 3 dB louder than a 250-watt amplifier. It is also much more likely to blow out one's speaker systems if used carelessly. Speaker systems can not handle unlimited power.

The reason for public acceptance of less-than-ideal program dynamic range in home music reproduction, in my opinion, lies in the ready availability of a knob, usually labelled VOLUME or LOUDNESS, and found on every receiver and amplifier. We turn this knob clockwise to increase the loudness. Perhaps, if we are lucky, the program reaches what we consider a natural level and is free of unpleasant sounds. Well and good, since this is what hi-fi is all about. Suppose that before this level is reached, however, we hear obvious and unpleasant distortion. Rather than try for higher levels, most people react by turning down the volume until the distortion becomes acceptable.

In turning down the volume, we have adapted the reproduced program level to the limitations of our equipment, and are willing to accept a less-than-natural listening level. In a very short time, most of us no longer find such levels unnatural, which is very fortunate, since it is manifestly impractical to generate concert hall levels in one's home unless the neighbors are distant or deaf or both.

The foregoing is why hundreds of thousands of people are very satisfied with 20-watt receivers, thousands more find the 60 to 80 watts of a good middle-priced receiver more than satisfactory, and only a few can justify the considerable expense of the super-power variety. Personally, I appreciate having 200 watts or so on tap when needed, but recognize that the listening benefits of even an increase to 300 or more watts will often be judged too subtle for the added cost. Of course, that will not stop manufacturers from creating such amplifiers or receivers, or dedicated audiophiles from buying them. I can only say, more power to them!

HARMAN-KARDON MODEL 730 AM/STEREO FM RECEIVER

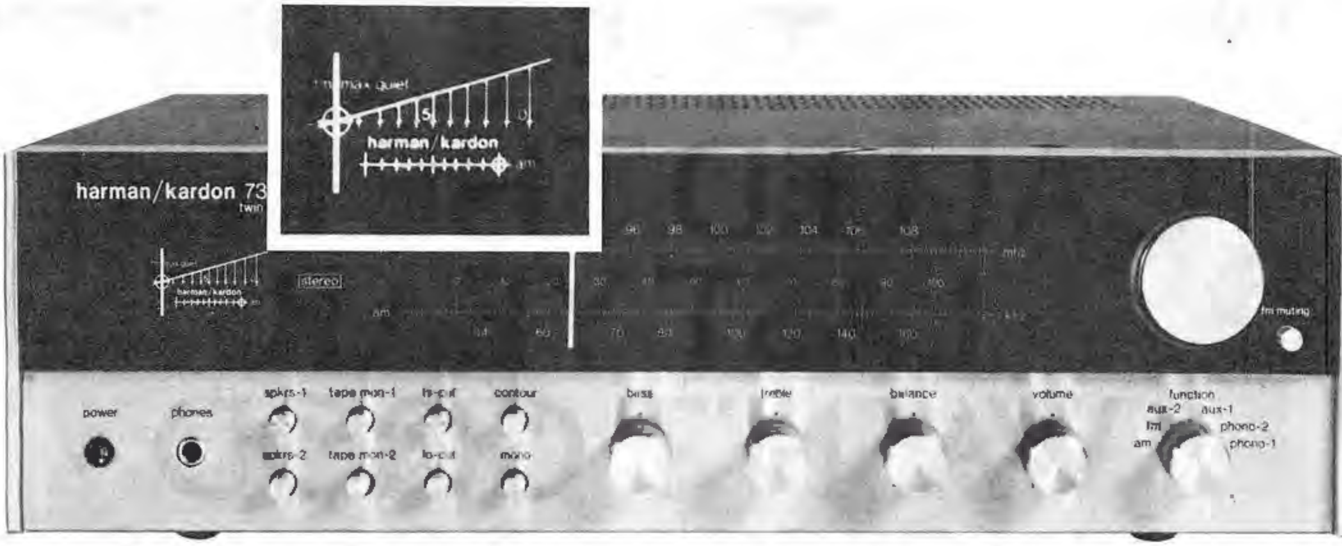
Medium-power receiver features unusual tuning meter.

HIRSCH-HOUCK LABS REPORT

Transient performance has long been an important part of Harman-Kardon's design approach to its high-fidelity products. To this end, the company has espoused amplifiers with very wide-band, low phase-shift circuits, and, as in the latest crop of H-K receivers, separate power supplies for the two channels. The Model 730 AM/stereo FM receiver that heads the current H-K receiver line embodies these design aims, although its 45-watt output power is barely moderate by present standards.

The styling of the Model 730 is distinctive, with the front panel presenting an uncluttered, utilitarian appearance. The most unusual external feature of the receiver is its tuning meter that, on FM, is actually a quieting indicator. It indicates the reverse of the usual signal-strength meter, with its pointer deflecting down-scale as signal-strength increases and noise level decreases. In effect, the meter indicates S/N in a qualitative, rather than a quantitative, manner. When the pointer enters a small circle at the lower limit of its travel, the receiver is fully quieted. For AM reception, the meter's pointer swings up-scale with increasing signal strength, as is usually the case with most of the conventional signal-strength meters.

Dimensions of the Model 730 are 5½" H × 17" W × 14½" D (14 × 43 × 37 cm). Suggested manufacturer's price for the Model 730 is $399.95.



Inset shows FM quieting indicator also used for AM signal strength.

Product Focus

Traditionally, the tuning meters in FM tuners and receivers indicated received-signal strength and/or center-channel tuning. Harman-Kardon has made a change from tradition by having its Model 730 stereo receiver's meter indicate relative signal quality so that, when nulled, tuning is as near perfect as possible for maximum S/N.

The signal-quality meter system employs a discrete transistor amplifier and two tuned resonant circuits. Each resonant circuit is tuned to about 100 kHz. The signal that drives this filter/amplifier combination is derived from an amplifier stage that follows the tuner's discriminator.

The amplifier/filter combination amplifies the noise that appears at 100 kHz at the discriminator's output. The 100-kHz frequency was chosen to minimize the effects of audio modulation on the meter's reading. (It prevents the meter pointer wobble common to multipath meters.)

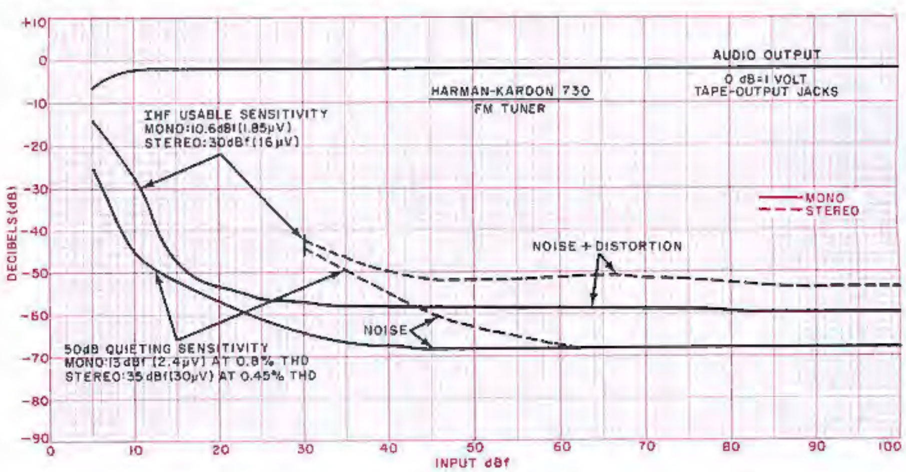
Since it is tuned to 100 kHz and "looks" only at that frequency, the metering system is quite selective and is thus able to give a pretty good indication of S/N. (If the frequency selected were more than 100 kHz, the discriminator would roll off the response.)

The system is not a true signal minus noise meter. Rather, it indicates noise itself. The circuit employs an agc system to prevent the meter from becoming crowded at one end, which linearizes the meter scale.

General Description. During the past year or so, we have seen several amplifiers and receivers with separate power supplies for the two audio channels, some of which utilized a single common power transformer and others with separate transformers. Doing this is supposed to eliminate interaction between channels that results when a common power supply impedance is used, especially at very low frequencies. The benefits of such isolation are difficult to demonstrate by objective or subjective means. Judging from the size of the power transformers and filter capacitors used in the Model 730, there is probably little difference in material cost between the Harman-Kardon approach and simply making a single, heavy duty supply with sufficient output capacitance to provide adequate isolation. Of course, with separate power supplies there is absolutely no difference in the performance of one channel whether or not the other channel is driven. The FTC-mandated preconditioning period of one hour at one third power, with both channels driven, is still necessary to bring the amplifier to a fully heated condition.

Harman-Kardon's wide-band philosophy is illustrated principally in the low-frequency response of the Model 730, which extends to 4 Hz and below. Clearly, most of the amplifier stages are direct-coupled. In a brochure furnished with the receiver, a 20-Hz square-wave response with only a 3% tilt is displayed to emphasize the receiver's extended low-frequency response.

On the rear apron of the receiver, there are pushbutton reset circuit breakers that protect the speaker outputs and a control shaft that permits adjustment of the FM muting threshold over a wide range. The ventilating slots at the rear of the top cover run across the width of the receiver. The output transistors and their heat sinks extend from front to rear, at the center of the receiver's chassis. Thus, the ventilating holes have very little direct cooling effect. Even so, despite the relatively large size of the receiver (for its power rating), it runs notably cool at all times.



Noise and sensitivity curves for FM section of receiver.

WHAT THE EXPERTS CALLED THE BEST LAST YEAR WASN'T GOOD ENOUGH FOR US.

"IT CANNOT BE FAULTED."

SA9500 — *Stereo Review*

"AS NEAR TO PERFECT AS WE'VE ENCOUNTERED."

TX9500 — *Popular Electronics*

"CERTAINLY ONE OF THE BEST... AT ANY PRICE."

TX9500 — *Modern Hi Fi*

Last year, the experts paid Pioneer's integrated amps and tuners some of the highest compliments ever.

The challenge was obvious: to build even better amps and tuners. Amps and tuners that would not only surpass anything we'd ever built before, but anything anyone ever built before. Here's how we did it.

THE NEW PIONEER TX9500II TUNER: EVEN CLOSER TO PERFECT.

When Popular Electronics said our TX9500 tuner was "as close to perfect" as they'd encountered, they obviously hadn't encountered our TX9500II. It features technology so advanced, some of it wasn't even perfected until this year.

Our front end, for example, features three newly-developed field effect transistors that work to let you pull in beautiful FM reception no matter how far you live from the transmitter. And no matter how much interference there is in your neighborhood.

Where most tuners give you one band for all FM stations, the TX9500II gives you two. A wide band with a new surface acoustic wave filter to take advantage of strong stations, and a narrow band with *five* ceramic filters to remove the noise and interference from weaker ones.

And where conventional multiplex circuits accidently cut out frequencies that add depth and presence to music, the multiplex circuit in the TX9500II doesn't. It features a Pioneer-developed integrated circuit that's far more accurate than anything else around. So the music begins to sound as if it's coming live from your living room, instead of from some radio station miles away.

THE NEW SA9500II AMPLIFIER: HOW TO GET THE MOST OUT OF THE BEST.

After building one of the world's best tuners, we had no choice but to create an amplifier that could match it.

The result is the new SA9500II. An 80* watt integrated amp that was designed to let you get everything out of your tuner. Perfectly.

Our output stage, for example, features a new parallel push-pull circuit that reduces total harmonic distortion to less than 0.1%. Well below the threshold of human hearing.

To all but eliminate cross-talk, the SA9500II comes with a separate power transformer for each channel, instead of the usual single transformer for both.

And where some amps give you two, or three tone controls, the SA9500II gives you four. Two for regular treble and bass, and two for extended treble and bass. They're calibrated in 2 dB click stops, which means you have a virtually endless variety of ways to get the most out of your music.

Obviously, both the SA9500II and the TX9500II are very sophisticated pieces of equipment. But all of the engineering skill that went into making them has gone into every tuner and amplifier in our new series II. No matter what the price, no matter what the specifications.

And that's something you don't have to be an expert to appreciate.

SA9500II—TX9500II

POWER MIN. RMS, 20 TO 20,000 Hz	80	SIGNAL TO NOISE RATIO	Mono 82dB Stereo 77dB
TOTAL HARMONIC DISTORTION	0.1%	FM SENSITIVITY (IHF '58)	1.5uV
PHONO OVERLOAD LEVEL	300mV	SELECTIVITY	(wide) 35dB (narrow) 85dB
INPUT: PHONO/AUX/TAPE	2/1/2	CAPTURE RATIO	(wide) 0.8dB (narrow) 2.0dB

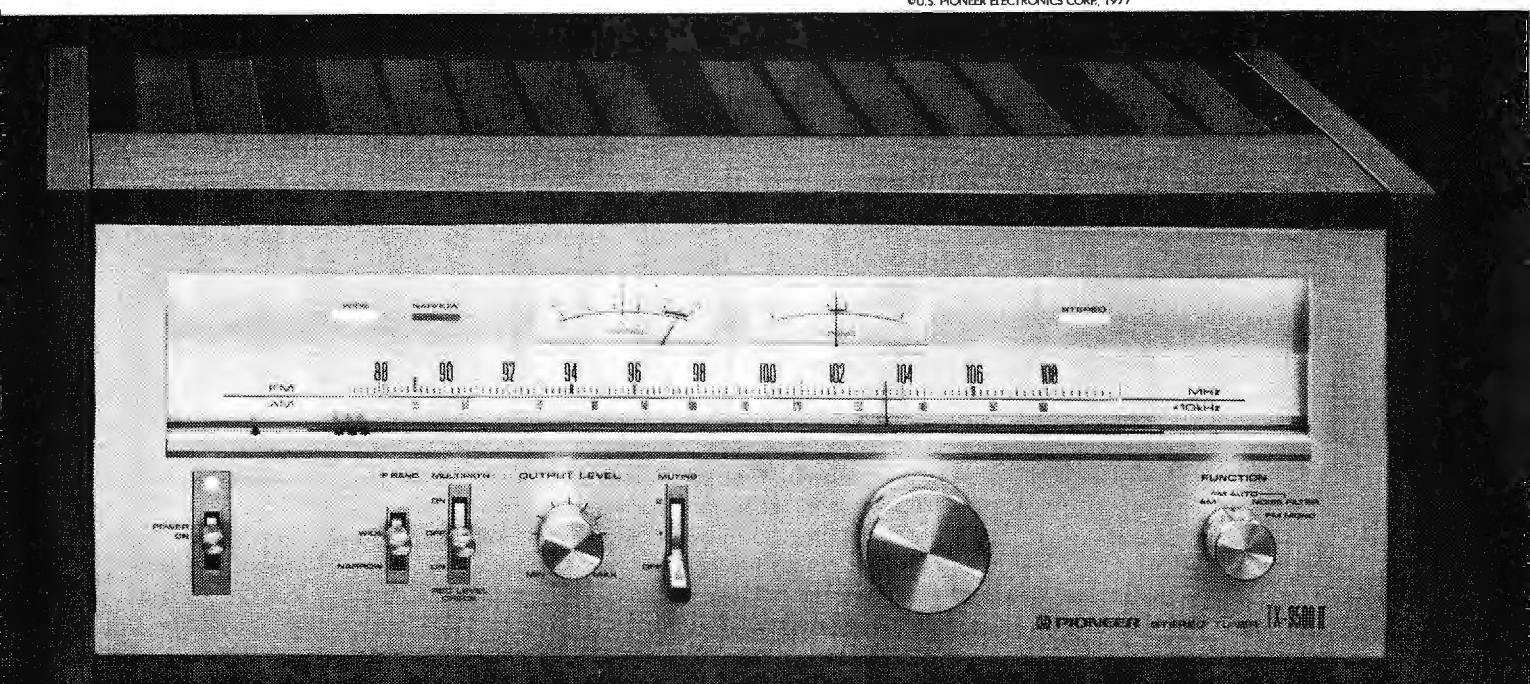
*Minimum RMS continuous power output at 8 ohms, from 20 to 20,000Hz, with no more than 0.1% total harmonic distortion.

High Fidelity Components

PIONEER®

WE BRING IT BACK ALIVE.

U.S. Pioneer Electronics Corp., 85 Oxford Drive, Moonachie, New Jersey 07074



TX9500II

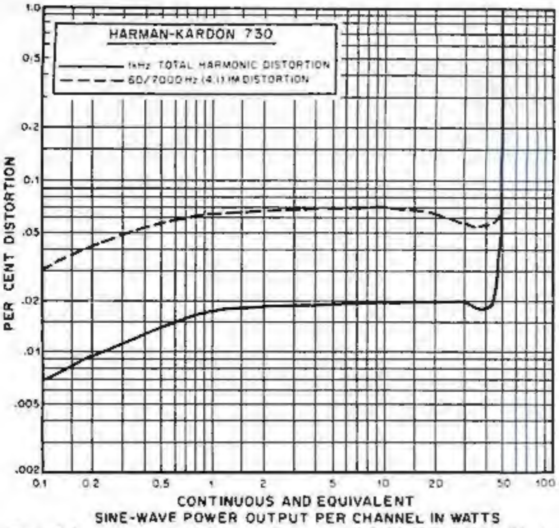
CIRCLE NO. 63 ON FREE INFORMATION CARD

PERFORMANCE SPECIFICATIONS

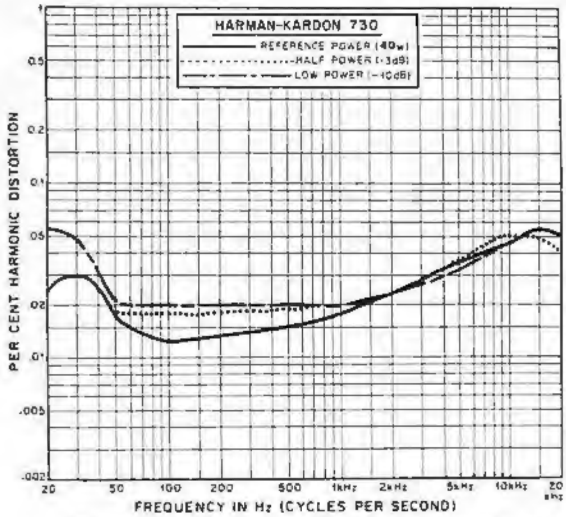
Specification	Rating	Measured	Comment
Power Output (8 ohms, 20–20,000 Hz)	40 W @ 0.1%THD	40 W, 0.05%THD	
Clipping Power (1000 Hz)	N/A	51 W (8 ohms) 64.8 W (4 ohms) 33.6 W (16 ohms)	
Frequency Response (1-watt output)	4Hz–140kHz ±0.5 dB	5Hz–220kHz ±0.5 dB	5 Hz is lower test limit
Rise Time	1.5 μs	1.5 μs	
Slew Rate	N/A	9 V/μs	
IM Distortion (60/7000 Hz, 4:1)	0.12% @ 40 W 0.15% @ 1 W	0.056% @ 40 W 0.065% @ 1 W	
Hum & Noise (unweighted)	−60 dB re 40 W	−83.6 dB (AUX) −81 dB (PHONO)	
Input Sensitivity (for 40-watt output)	150 mV (AUX) 2.5 mV (PHONO)	136 mV (AUX) 2.2 mV (PHONO)	1000 Hz
Phono Overload (1000 Hz)	95 mV	105 mV	
RIAA Equalization Accuracy	±1 dB	±1 dB	30–15,000 Hz
FM Sensitivity: IHF MONO −50 dB MONO −50 dB STEREO	 1.9 μV 3.5 μV 35 μV	 1.85 μV (10.6 dBf) 2.4 μV (13 dBf) 30 μV (35 dBf)	
Ultimate S/N	70 dB	68.5 dB (MONO) 68 dB (STEREO)	
Capture Ratio	2 dB	1.76 dB	
Image Rejection	80 dB	85 dB	
AM Rejection	60 dB	70 dB	
Alternate Channel Select.	80 dB	71.4 dB	
Adjacent Channel Select.	N/A	7.8 dB	
Stereo Separation (1000 Hz)	40 dB	47 dB	
FM Distortion (1000 Hz)	0.2% MONO 0.3% STEREO	0.11% MONO 0.29% STEREO	65 dBf
Pilot Carrier Leakage	N/A	−75 dB	

User Comment. The RIAA phono equalization is not only very accurate over the defined range of 30 to 15,000 Hz (it falls off somewhat at the lowest frequencies), but it is totally unaffected by cartridge inductance. The audio distortion of the receiver was quite insignificant, and the clipping power of about 50 watts should be adequate for most home installations, with speakers of normal efficiency.

Although the tone controls have a satisfactory range and choice of turnover frequencies, the high-cut filter is essentially useless. (It virtually duplicates the response of the treble tone control near its minimum setting.) A 6-dB/octave filter with a −3-dB response at 3000 Hz is



Total harmonic distortion and 60/7000-Hz distortion.



Harmonic distortion at three power levels.

really not worth the control space allotted to it on the panel. The low-frequency filter, although not ideal, is considerably better; it has a 12-dB/octave slope and a −3-dB frequency of 50 Hz. The loudness compensation boosts only low frequencies, to a moderate degree, yet manages to sound undesirably heavy because it affects almost the entire range below 1000 Hz.

The FM tuner section was excellent, handily meeting or surpassing almost every specification. The quieting meter proved to be a very accurate tuning indicator. Although this point is not mentioned in the instruction manual we noted that the meter's pointer fluctuated with multipath distortion and gave a steady indication on signals free of that effect. This represents the first triple function FM tuning meter we have used (center channel, as shown by a definite minimum reading; relative signal strength; multipath distortion). Its only drawback, compared to conventional meters, is that one must tune quite slowly through a station to establish the minimum reading, and then tune back to that point—again, slowly—since the meter seems to respond with a lag. In contrast, a typical center-channel meter allows one to stop tuning as soon as the pointer reaches the indicated center.

Although the FM tuner had a ruler-flat frequency response to 15,000 Hz, the 19-kHz pilot carrier leakage was a very low −75 dB. This speaks well for the design of the multiplex filters in the tuner section. The stereo channel-separation characteristic was unusual, with a very wide separation of more than 60 dB at 30 Hz, which decreased smoothly to 24 dB (still good) at 15,000 Hz. As a whole, the tuner's FM performance was excellent. The AM tuner was as limited in its frequency response as most we have used, but was exceptionally quiet and free of the buzzes and noises that usually accompany a scan of the AM broadcast band.

In listening tests, the Model 730 did a first rate job. Like most good receivers, it sounded as good or as bad as the program material allowed. When we transmitted a high-quality signal to it through our laboratory signal generator, it left nothing to be desired. The muting circuit has a slight delay that allows the dial to be twirled from one end of the FM band to the other in perfect silence; about a second after a station is tuned in, its modulation appears. In slow tuning through a station, we heard only a faint click as the muting operated.

One of our two criticisms of the Model 730 (both relate to its FM tuner section) concerns a basic design factor and the other is certainly due to a fault in our test sample. The pointer of the tuning meter is not illuminated or even colored white for contrast against the black and dark green background of the meter scale. As a result, it can hardly be seen, except at point-blank range. On our test unit, the FM dial calibration was poor, showing the result of a misalignment. It was accurate below 94 MHz but had an error of 300 kHz at 96 MHz, and 700 kHz at 106 MHz. As a result, tuning was approximate over much of the band.

The Harman-Kardon Model 730 is convincing evidence that a medium-priced receiver can deliver top-quality sound, combined with all the operating flexibility most people will ever need and an attractive appearance.

SHARP MODEL RT-3388 FRONT-LOADING CASSETTE DECK

Built-in "computer control" system and LCD display are featured.

HIRSCH-HOUCK LABS REPORT

The Sharp Model RT-3388 is a basic cassette deck of conventional design and good quality. Where it differs from other cassette decks is in its built-in "computer control" system that gives it an operating flexibility and convenience previously unavailable in a consumer deck. The cassette deck proper is a two-head, single-motor transport with a servo-controlled dc motor. The front-loading mechanism provides excellent visibility of the entire cassette through its clear plastic window that makes up almost the entire cassette compartment door. The door can be removed by loosening two thumbscrews to provide complete access to the tape heads for cleaning and adjustment. The operating controls are mechanical "piano-key" levers that are solenoid assisted for certain functions.

The cassette deck measures 17 3⁄8"W × 12 7⁄8"D × 5 3⁄8"H (44.1 × 32.7 × 13.7 cm) and weighs 20 lb (9.1 kg). Its nationally advertised retail value is approximately $350.

General Description. The deck has separately switchable bias (HIGH/LOW) and equalization (70/120 μs). The manual that accompanies the deck lists recommended settings for most popular tape brands and formulations. Unlike the case with most recorders, the manual

also identifies the specific tapes for which the deck was adjusted at the factory. They are Maxell UD (normal), Maxell UD-XL II (HIGH/70 μs), and Sony Ferrichrome (LOW/70 μs).

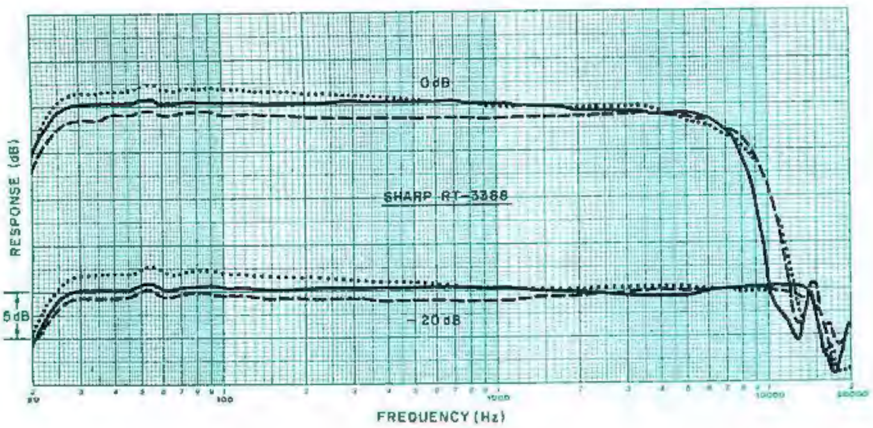
The recorder has built-in Dolby noise reduction, separate microphone and line inputs that can be mixed, and large illuminated level meters supplemented by a PEAK LED indicator. While this is conventional, the rest of the deck is far from conventional, as is immediately obvious.

A "computer" keyboard and display panel dominate the center of the front panel. The "computer" that controls the operation of the deck provides memory functions for stopping the tape at a preselected point, either in normal or fast speeds. It also supplies the tape index counting function usually performed by a belt-driven mechanical counter. It controls Sharp's Automatic Program Locator Device (APLD) that can be set to skip any number of separately recorded selections (up to 19 in all) on a tape, stopping and playing a preselected piece that occurs later in the tape. The APLD contains a quartz controlled digital clock that is constantly in operation. When the machine is plugged into the power line, the clock is powered whether or not the recorder is turned on. Internal batteries can power the clock for up to a year without recourse to the ac power line. The clock can turn the deck (and anything plugged into its single switched outlet) on and off at preset times with split-second accuracy and time the running of a tape in minutes and seconds. It also provides the usual index-counter function. As a timepiece, it can be set for a 12- or a 24-hour format and automatically provides AM and PM identification in the 12-hour mode.

All the display functions appear on an LCD (liquid-crystal display) panel located above the keyboard. When the recorder is turned off, the display automatically reverts to its clock function. Seconds are indicated by the blinking of the colon that separates the hours and minutes digits. When the deck is turned on,

SPECIFICATION	RATING	MEASURED	REMARKS
Wow & Flutter	0.06% wrms	0.065% unweighted rms	
Frequency Response	30-13,000 Hz ±3 dB (normal)	25-14,200 Hz ±1 dB UD-XL I (LOW/120 μs)	
	30-15,000 Hz ±3 dB (UD-XL II)	24-14,600 Hz ±1 dB UD-XL II (HIGH/70μs)	
	30-16,000 Hz ±3 dB (FeCr)	22-15,000 Hz ±3 dB Sony FeCr (HIGH/120 μs)	
Playback Response	N/A	40-12,500 Hz ±2 dB TDK AC-337 (120 μs)	
		40-10,000 Hz ±0.5 dB Teac 116SP (70 μs)	
S/N Ratio	55 dB (normal)	47.4 dB UD-XL I 45.3 dB UD-XL II 44.7 dB Sony FeCr	3% playback distortion, unweighted
		56.0 dB UD-XL I 58.8 dB UD-XL II 56.0 dB Sony FeCr	CCIR/ARM weighted
		65.6 dB UD-XL I 66.5 dB UD-XL II 64.4 dB Sony FeCr	CCIR/ARM weighted, with Dolby
Noise Increase		+6.5 dB	MIC input at maximum gain
Sensitivity	50 mV (LINE) 0.2 mV (MIC)	54 mV 0.2 mV	
Output Level	775 mV at 0 dB (LINE) 89 dB (8-ohm PHONES)	Varies with tape; 700 to 800 mV	Phones not measured
Playback Distortion (0-dB record level)	N/A	0.45% UD-XL I 0.25% UD-XL II 0.80% Sony FeCr	1000-Hz test tone
Crosstalk (L – R at 1000 Hz)	N/A	−51 dB TDK AC-352	
PEAK indicator ON	N/A	-6.5 dB	
METER BALLISTICS	N/A	10% overshoot	0.3-s, 1000-Hz tone bursts
METER CALIBRATION	N/A	within 0.5 dB	
FAST FORWARD AND REWIND TIME	N/A	94 s	C-60 cassette

Note: Manual specifies LOW bias and 70-μs equalization for FeCr tape. These settings yielded sharply rising high-frequency response; flattest response was obtained with HIGH bias and 120-μs equalization.



Frequency response for three types of tape at 0 and −20 dB.

the display becomes a tape counter, although any of its other functions can be selected at that time by pressing the proper buttons. Arrows in the display indicate direction of tape motion and tape speed (the latter by blinking on and off when a fast speed is selected). A Dolby trademark symbol appears in the display when the DOLBY switch is on. Short bars above each column of keys indicate which function has been selected, and a letter M appears above a bar when specific memory data has been entered for a given function.

The computer-controlled functions of the Model RT-3388 are so diverse that most of the very comprehensive instruction manual is devoted to them, with the aid of copious illustrations and photographs. Only nine of the 36 pages in the manual deal with normal tape recording functions. In general, the desired information, whether it be an index counter reading or a time, is fed into the computer by sequential operation of the keys, followed by a touch of the S (set) key. Previously set functions, which are not incompatible with the new one, remain unchanged and in use. Thus, one can switch between index counter, seconds counter, and actual time display at will while the tape is running without miscounting or affecting the operation of the machine. When the recorder is turned on, the LCD panel is back lit for full visibility. With the power switch off, a separate switch can be used to activate only the display lights so that the clock can be used at any time.

The "computer" section is physically very similar to a hand-held calculator in its size and configuration of keyboard and display. It extends only about ½" (12.7 mm) behind the panel and cannot be seen without extensive disassembly. According to the manual, a single LSI chip supplies all computer functions. Most of the remaining electronic circuits are on a single large circuit board that is very clearly labelled with individual circuit reference symbols for all components and the function of each section of the board (Dolby, Preamplifier, etc.). A second large board contains the power supply and control circuitry. The tape transport occupies only a small fraction of the internal space of the recorder.

User Comment. This is a most impressive product, largely because it offers so much for such a moderate price without appearing to have sacrificed any significant aspect of its performance. The tape saturation characteristics at a 0-dB recording level, compared to the −20 dB response, suggest that the heads are of only ordinary efficiency, neither better nor worse than one would expect on a machine in the $250 to $300 price range. On the other hand, the measured wow and flutter were about as low as we have measured on any cassette recorder and are better than we would expect to find at this price.

The recorder delivered excellent sound quality, both from prerecorded tapes and from recordings we made off the air and from records. We also recorded FM tuner interstation hiss at a −10-dB level and compared the playback to the original sound. This test simultaneously checks frequency response and tape saturation effects and reveals even slight deviations from an accurate recording. With Maxell UD-XL I tape, the results were good, but not quite perfect; we could hear a slight dulling of the highest frequencies. The "chrome equivalent" Maxell UD-XL II, on the other hand, yielded perfect reproduction of the highest frequencies. In the case of ferrichrome tape, we are not certain how to judge the machine's performance. With the HIGH bias and 120-µs equalization that gave flattest frequency response, we could hear a slight difference between the input and output of the recorder. Using the recommended settings of LOW bias and 70-µs equalization, the results were audibly perfect, as good as with UD-XL II, in spite of the measured low-level frequency response being far from flat. Obviously, some user experimentation would be in order if FeCr tape is to be used. We also obtained completely acceptable results

Product Focus

The unique feature of the Sharp Model RT-3388 cassette deck is its one-chip microcomputer/liquid crystal display (LCD). Commands and numbers for the memory are activated by a 24-key matrix.

The microprocessor chip that controls the deck is a single, square 60-pin CMOS LSI device. It has a built-in clock, 54 commands, 2268 bytes of ROM, and 96 words of RAM. A crystal oscillator supplies energy for the clock, timer, and counter that indicates tape time in seconds.

The timer serves as an alarm clock and sleep-time indicator. It also permits unattended recording and can switch on and off the tape deck and a device plugged into the deck's accessory outlet. The timer features two-stage operation: one for independent timer stop; the other for switching from timer start to timer stop and vice versa.

When the tape counter is set, the deck plays to the present point and automatically shuts off. Also in fast forward and rewind, the deck automatically stops at the preset point.

The tape counter keeps track of the tape passing the heads but cannot accurately register absolute values. A second counter is provided for more accurate indications.

Setting the number of a selection on the tape puts the deck into fast forward or rewind to locate the desired selection. This automatic locating device can be keyed for as many as 19 program steps ahead of or behind the desired selection.

with a number of comparable tapes of all kinds, using the appropriate switch settings. The tapes chosen for testing were those specified by Sharp; they gave the flattest response in our tests.

The computer functions were fascinating to use. Space does not permit a full account of what this machine can do (many pages of the manual are devoted to that), but we were continually impressed by the accuracy with which it responded upon reaching a preset point on a tape, whether in a memory mode or on the APLD function. The latter counts the silent intervals between recorded selections to locate the desired point, so it cannot be "foolproof" in its operation (when making one's own recordings, an EDITOR switch cuts off the program while a short blank section is recorded between program segments). All in all, we found that the APLD worked correctly in the vast majority of cases, even with commercially recorded tapes. To fully utilize the capabilities of the deck, one must only study the manual carefully and practice extensively with its controls to become familiar with it.

In sum, the Sharp Model RT-3388 is an above-average tape recorder for its price in all basic performance aspects and is unique at this time in its operating features. It is as much fun to use and to look at as it is for listening. Once you have been exposed to the comprehensive LCD panel, mechanical counter and function display indicators on other recorders appear old fashioned.

CIRCLE NO. 102 ON FREE INFORMATION CARD

WHARFEDALE MODEL E50 SPEAKER SYSTEM

High-efficiency system produces crisp sound and tight bass.

HIRSCH-HOUCK LABS REPORT

Wharfedale has re-entered the U.S. hi-fi market after an absence of several years with a new line of highly efficient speaker systems. The British Company's new Model E50 speaker system resembles some of the recent products from Japan with its drivers surrounded by machined aluminum rings set against a flat black speaker board. The grille is an open-mesh plastic that appears to be equally transparent to light and sound. Cutouts provide access to the two level control switches, labelled HIGH and LOW, even with the grille in place.

The Model E50 speaker system measures 32"H × 14"D × 13½"W (81.5 × 36 × 43.2 cm) and weighs 70 lb (32 kg). Nationally advertised value is $390.

General Description. The Model E50 ("E" stands for efficiency) is designed to deliver high acoustic levels without dynamic compression or other distortion when driven at moderate power levels. Its 10" (25.4-cm) woofer operates in a vented enclosure, the 4" (10.2-cm) port of which has been designed to operate as a fourth-order, maximally flat Butterworth system. At 800 Hz, there is a crossover to a 4" (10.2-cm) cone driver, while at 7000 Hz, there is another crossover to a horn-loaded compression driver that has a 1" (2.54-cm) diaphragm. The frequency response is rated at 55 to 18,000 Hz ±3 dB.

The system's level controls are five-position switches, with their 0 (maximum) settings providing the flattest response. The frequency ranges affected by these switches do not correspond exactly to the range of any single driver. For example, the LOW control, which should really be called MID, varies the output between 200 and 2000 Hz, with a maximum reduction of 5 dB. The HIGH switch produces a shelf in the response above 2000 Hz, with a maximum range of 5 dB. The system impedance is normally 8 ohms, and it has been designed to be greater than 6.8 ohms at all audible frequencies.

Laboratory Measurements. We measured the low-frequency response, up to about 300 Hz, with a closely spaced microphone. We separately recorded the response of the port and the woofer cone and combined the two to obtain a single reading. The highs were measured in the reverberant field of the room, using a swept warble tone signal and averaging the curves obtained from the two speakers in a normal setting for stereo listening.

With due allowance for the very different measurement techniques used by Wharfedale and ourselves, it was clear that the speaker system easily met its response rating. A moderate high-frequency peak was the only part of the composite response curve that exceeded the ±3-dB limits. From 45 to 8000 Hz, the response was smooth and uniform, within ±3 dB. It rose to about +5 dB at 11,000 or 12,000 Hz. The woofer's response, from 50 to 300 Hz, was exceptionally flat, attesting to the success of the computer design employed.

The low-frequency distortion at a 1-watt input was a mere 0.5% or so down to 60 Hz. It rose to only 5% at 30 Hz. At a 10-watt drive level, the distortion was less than 2% down to 50 Hz, rising to 6.7% at 35 Hz. When the input was adjusted to maintain a 90 dB SPL at 1 meter with changes of frequency, the result was similar to the 10-watt measurement except that the distortion rose more rapidly below 50 Hz.

The level controls had approximately the specified effects. (Typical response curves as well as fairly complete system specifications are on a nameplate affixed to the rear of the cabinet.) The HIGH control began to take effect at about 1000 Hz, overlapping the LOW control, which modified the response between 150 and 1500 Hz. The system

Learn electronics at your own pace – at the lowest cost.

COURSE 1: DC Electronics

The first step toward a complete understanding of a fascinating and rewarding field of endeavor. As you'd expect, Course 1 is simply and logically arranged and assumes no prior electronic knowledge. It begins at basic electron theory and goes on in detail with nothing omitted. Course 1 comes with everything you need for successful completion and, most importantly, a high degree of understanding. The only materials needed are a record player, a few basic hand tools and a VOM. Progressing at your own established pace, you learn in an unhurried environment free from pressure. Like all Heathkit courses, learning is easy with simple, step-by-step "programmed" instructions. Audio aids help emphasize the text material and an optional final exam lets you test your overall comprehension.

Essentially, Course 1 covers current, voltage, resistance, magnetism, Ohm's Law, electrical measurements, DC circuits, inductance and capacitance. In short, a complete foundation in basic electronics. Included are texts, records, and 56 electronic components for 20 different experiments. Also available is the ET-3100 Experimenter/Trainer that helps you perform projects and experiments quicker. The average completion time for Course 1 is 20 hours.

If you choose to take the optional final exam and score a grade of 70% or better, you will receive a Certificate of Completion and 2.0 Continuing Education Units (CEUs). CEUs are a nationally-recognized way of acknowledging participation in non-credit adult education.

Course EE-3101 .... 39.95

COURSE 2: AC Electronics

The second of the Heathkit basic electronics courses which coupled with Course 1, forms the foundation for all the courses that follow. The same straightforward, simple format is utilized to teach you the theory of alternating current. Course 2 includes all the necessary material for best understanding and successful course completion. The only other materials required are a record player, a few basic hand tools and a VOM. Like the other Heathkit Self-Instruction Courses, AC Electronics is designed to let you progress at your own pace moving up when you're ready. Step-by-step, "programmed" instructions make it a rapid, easy process. Records reinforce the text material. An optional final exam lets you evaluate your understanding of the material.

Course 2 basically covers alternating current, AC measurements, capacitive and inductive circuits, transformers and tuned circuits. For best understanding, Course 2 requires the completion of Course 1 (or equivalent knowledge). Included are texts, records and 16 electronic components for 8 different experiments. The optional ET-3100 Experimenter/Trainer kit enables you to perform projects and experiments quicker. The average completion time for Course 2 is 15 hours.

If you choose to take the optional final exam and score a grade of 70% or better, you will receive a Certificate of Completion and 1.5 Continuing Education Units (CEUs). CEUs are a nationally-recognized way of acknowledging participation in non-credit adult education.

Course EE-3102 .... 39.95

COURSE 3: Semiconductor Devices

One of the most important of the Heathkit Self-Instruction Courses and the one that reveals the technology you *must* know to stay ahead. What you'll learn in this course is absolutely necessary for understanding the solid-state devices prevalent in nearly everything electronic. Course 3 covers every aspect of a fascinating subject in simple, easily-understood terms. Everything is included except a few basic hand tools, a record player and a VOM. Progressing at a self-established pace, you move through the material as you are ready. Step-by-step "programmed" instructions make it a short, easy process. Records reinforce the text material. An optional final exam is available upon request if you wish to test your overall comprehension of the course material.

Course 3 covers semiconductor fundamentals, diodes, zeners, bipolar transistor operation and characteristics, FETs, thyristors, ICs and optoelectronics. Included are texts, records and 27 electronic components for 11 different experiments. Also available is the ET-3100 Experimenter/Trainer Kit that enables you to perform projects and experiments quicker. Prerequisites for the semiconductor course are Courses 1 and 2 or equivalent knowledge. The average completion time for Course 3 is 30 hours.

If you choose to take the optional final exam and score a grade of 70% or better, you will receive a Certificate of Completion and 3.0 Continuing Education Units (CEUs). CEUs are a nationally-recognized way of acknowledging participation in non-credit adult education.

Course EE-3103 .... 39.95

COURSE 4: Electronic Circuits

This course lets you utilize what you've learned in Courses 1 through 3 to understand the operation of complex electronic circuitry. It's just as easy to follow as the first three courses and also includes all the materials you need except the small hand tools, VOM and record player. Like the other courses, you work at your own pace aided by the records (or optional tapes) and may test yourself with the optional final exam.

Course 4 covers basic amplifiers, typical amplifiers, operational amplifiers, power supplies, oscillators, pulse circuits, modulation and demodulation with emphasis on integrated circuits. Included are texts, records and more than 110 electronic components for 18 different experiments. The ET-3100 Experimenter/Trainer Kit is also available as an option. Course 4 requires the completion of Courses 1 through 3 or equivalent knowledge. The average completion time for Course 4 is 40 hours.

If you choose to take the optional final exam and score a grade of 70% or better, you will receive a Certificate of Completion and 4.0 Continuing Education Units (CEUs). CEUs are a nationally-recognized way of acknowledging participation in non-credit adult education.

Course EE-3104 .... 49.95

Keep learning and growing – order today!

Prices are mail order net F.O.B. Benton Harbor, Michigan.
Prices and specifications subject to change without notice.

For advanced learning; DIGITAL TECHNIQUES

One of our most advanced courses in Digital Techniques prepares you for the world of computers and microprocessors, with particular emphasis on circuit design. Covers digital fundamentals, semiconductor devices for digital circuits, digital integrated circuits, Boolean algebra, flip-flops and registers, sequential logic circuits, combinational logic circuits, digital design and digital applications. Discusses TTL, ECL, CMOS, PMOS, NMOS; integrated circuits; SSI, MSI and LSI; ROM's, PLA's, microprocessors, computers and more. Assumes completion of Heathkit courses 1 through 4 above, or equivalent knowledge. The optional digital techniques experimenter/trainer helps you perform all the experiments in the course, and when you complete the course, build and design your own circuits. Course includes text, records and 44 parts for 24 different experiments. Average completion time, 40 hours. 4.0 Continuing Education Units and a certificate for passing final exam.

Course EE-3201 .... 54.95
EEA-3201, Optional Cassettes 6.95
Kit ET-3200, Digital Trainer Kit 79.95

Recommended Test Equipment

You need a quality multimeter like the Heathkit IM-5284 to complete these courses. Tests and experiments are quicker and more precise with this solid-state VOM that measures AC and DC volts, ohms and DC current. The IM-5284 is easy to build and operate even for the first time kit builder and will continue to be very useful long after you've completed your Heath courses.

Kit IM-5284 .... 37.95

CIRCLE NO. 5 ON FREE INFORMATION CARD

NOTE: Having completed the above courses, you will be ready to move up to our other advanced courses; Microprocessors and Computer Programming – the super technology of tomorrow.

HEATH
Schlumberger

ED-114

Order Form/Agreement

Heath Company, Dept. 010-402
Benton Harbor, Michigan 49022

Please send me items checked below and include FREE $7.95-value Soldering Iron.

☐ Send *one* course (checked below) *with the Experimenter/Trainer* (ET-3100) at the special price of only $89.95 plus $3.00 shipping and handling.

☐ DC (EE-3101) ☐ AC (EE-3102) ☐ Semiconductors (EE-3103)

☐ Send me the *Electronic Circuits Course* (EE-3104) *with the Experimenter/Trainer* (ET-3100) at the special price of only $99.95 plus $3.00 shipping and handling.

☐ Send *all four of the courses above* (EE-3101, 3102, 3103, 3104) with the Experimenter/Trainer at the special price of just $199.95 plus $4.50 shipping and handling.

In addition, please send the following *courses (less trainer):*

☐ DC (EE-3101) ☐ AC (EE-3102) ☐ Semiconductors (EE-3103) for just $39.95 plus $1.50 shipping and handling each.

☐ Electronics Circuits (EE-3104) for just $49.95 plus $1.50 shipping and handling.

☐ Send me the *Digital Techniques Course (EE-3201) with its Experimenter/Trainer* (ET-3200) for only $124.95 plus $3.00 shipping and handling.

☐ Also send me the IM-5284 *VOM kit* for just $37.95 plus $1.50 shipping and handling.

Michigan residents add 4% sales tax.

I enclose ☐ check ☐ money order for $________; or, Charge to my:
☐ BankAmericard Acct. ☐ Master Charge Acct.

No.________________ Exp. Date________

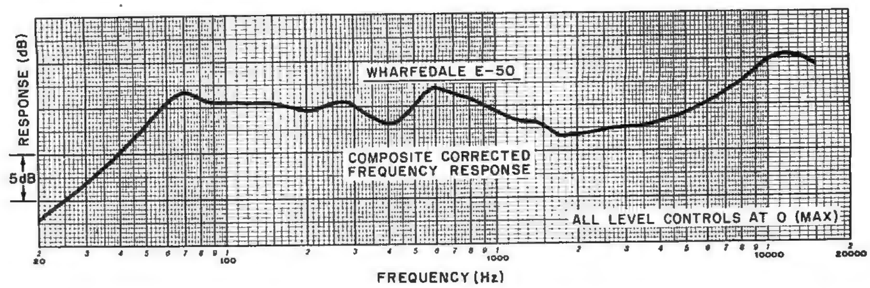
If Master Charge, include Code No.________________

Signature: X________________
(necessary to send merchandise)

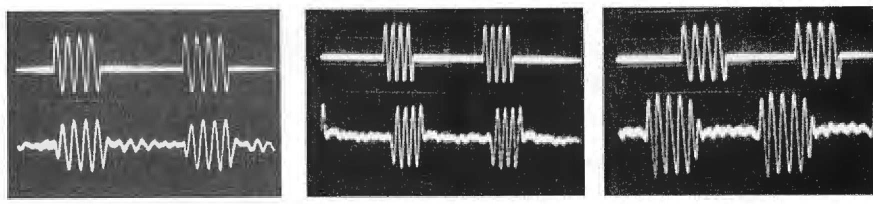
NAME (please print)________________

ADDRESS________________

CITY________________STATE________________ZIP________



Composite corrected frequency response with all level controls at zero.



Tone burst responses at frequencies (left to right) of 100, 1000, and 7000 Hz.

impedance varied considerably with frequency, with a maximum of about 40 ohms at 22 Hz and a minimum of about 6 ohms at 200 and 1500 Hz.

The tone-burst response was exceptionally good, with nearly perfect burst shapes at most frequencies. The high efficiency of Wharfedale's computer-designed speaker system was dramatically illustrated by the Model E50's ability to deliver a 95-dB SPL at 1 meter when driven by 1 watt of random noise in the octave centered at 1000 Hz.

The simulated "live-versus-recorded" listening test confirmed that the measured smoothness and range of the system's frequency response was quite real. The chief difference between the sound of our "live" source (a reference speaker system that reproduced a specially taped program) and the sound of the Model E50 attempting to imitate it was an added brilliance in the sound of the latter. This could have been inferred from its slightly rising high-frequency response characteristic. Its effect was to add "sizzle" or "bite" to the sound of wide-range program material that contained appreciable high-frequency energy. The most accurate reproduction was with the HIGH switch at its minimum setting, but the highs were still "hot."

User Comment. The sound of the Wharfedale Model E50 might appeal more to the pop or rock music listener than to the classical enthusiast, especially since it can produce prodigious levels of very clean sound when driven by a modestly priced receiver or amplifier. It lacks the deep bass response favored by some people (although it is by no means shy of bass). However, it is outstandingly flat and true over most of the audio range.

The speaker system seemed to us to have a razor-sharp, almost clinical quality. This may be related to its notably good transient response, as confirmed by our tone-burst tests, as well as to its accentuated top-end response. As a rule, we prefer to set a speaker system's balance controls only once, upon installation. In this case, we found it desirable to readjust the HIGH level control according to the program content. With most FM broadcasts and records, we found that one or two steps of high-frequency reduction gave the best results. With programs containing exceptionally strong high-end content, such as the Sheffield direct-disc recordings played with a good moving-coil cartridge, we had to cut the speaker system's highs all the way down. (The LOW switch was left at maximum.)

We found the Model E50 to be an exceptionally clean and easy-to-listen-to speaker system. Since its emphasis was principally at frequencies above 10,000 Hz, its high-frequency response was never audible as stridency or even as "presence." Instead, it gave a crispness or edge to the sound that seemed well matched to the very tight and non-boomy bass reproduction of the speaker system. The ability to operate effectively at any usable listening level from an amplifier rated at, perhaps, 20 watts output is a major advantage of this speaker system over most of its competitors.

CIRCLE NO 103 ON FREE INFORMATION CARD

VERSATILITY – UNMATCHED

by any other micro-computer system

COMPUTERS	TAPE SYSTEMS	MEMORY – 4K, 8K, 16K & 32K
TERMINALS	DISK SYSTEMS	PROGRAMMABLE REAL TIME CLOCK
PRINTERS	GRAPHICS	CALCULATOR INTERFACE
SOFTWARE	PROM PROGRAMMER	A - D CONVERTER

Write, or circle our reader reply number for a catalog describing our complete line of computer hardware and software.

NOW AVAILABLE IN BOTH KIT AND ASSEMBLED FORM.

SOUTHWEST TECHNICAL PRODUCTS CORPORATION
219 W. RHAPSODY
SAN ANTONIO, TEXAS 78216

Popular Electronics
APRIL 1978

BY JOSEPH CARR

HOW TO DESIGN & BUILD POWER SUPPLIES

PART 1

Basics of transformers, rectifiers, filters, voltage regulators and protection circuits.

WHEN YOU design or build projects, particularly large-scale designs in which many transistors and/or IC's are used, most of the effort goes into creating the final circuit and the printed circuit board. All too often, the power supply is just an afterthought. This is unfortunate because even a well-designed and assembled project may operate borderline if the power supply is not delivering the correct voltage at the required current. This problem is compounded when the supply must deliver large amounts of current, as in multi-IC digital circuits, especially microcomputers. Hence, the power supply deserves special attention, since it is often critical to the success of an electronic project.

In this first of a two-part article we will discuss power supply basics, some design concepts, etc. By the end of Part II, you should be able to design low-voltage, high-current power supplies that can perform as required for just about any project.

Transformers. The transformer is generally a voltage converter. It reduces the standard 117-volt ac power line potential to the lower voltages required in solid-state electronics. Most discrete circuits operate with potentials in the 1.5-to-28-volt range; linear IC systems operate in the range from ±4.5 to ± 18 volts; CMOS circuits require between 4 and 18 volts; and TTL requires the use of a tightly regulated 5-volt supply line.

Because a transformer is very efficient, stepping the line potential down in the secondary winding increases the current available for any given voltage level. The primary VA (volts times amperes) rating is very nearly equal to the VA rating of the secondary. Simply stated, $E_{pri} \times I_{pri} = E_{sec} \times I_{sec}$, where E_{pri} is the potential in the primary winding (117 volts ac); I_{pri} is the primary current; E_{sec} is the voltage in the secondary; and I_{sec} is the secondary current.

Rectifier. The rectifier converts the alternating current from the transformer's secondary into pulsating direct current (dc). The simplest of rectifiers is the half-wave circuit shown in Fig. 1.

All rectifiers operate on the same principles, whether they are solid-state or vacuum-tube types. They conduct current in only one direction. When an ac sine wave is applied to the input of this circuit, current passes through the rectifier only when its anode is more positive than its cathode, as in Fig. 1A. On the other half of the ac cycle, the rectifier

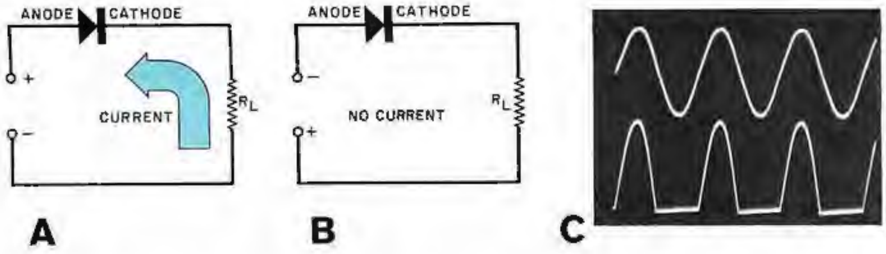


Fig. 1. Forward-biased diode (A) conducts current while reverse-biased diode (B) does not. In (C), upper trace is ac input, lower trace is pulsating dc across load.

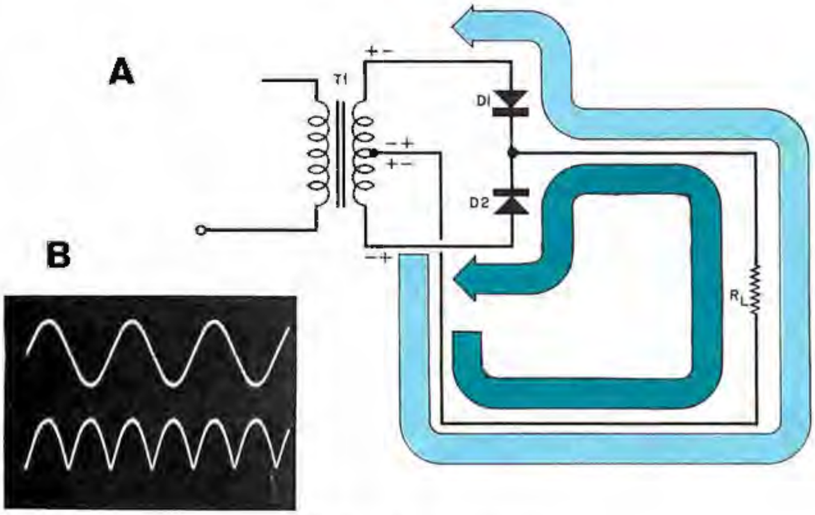


Fig. 2. At (A) is fullwave rectifier. Ac in primary of T1 is upper trace in (B), pulsating dc is at bo'tom.

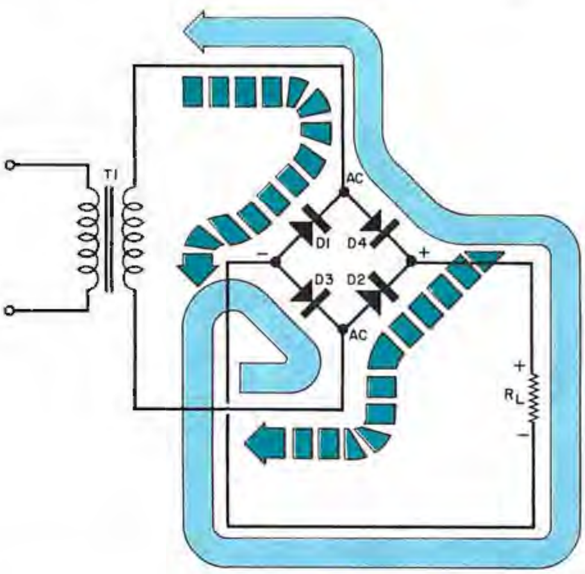


Fig. 3. A full-wave bridge rectifier. Broken lines show current flow during each half of the ac input cycle.

is reverse-biased (Fig. 1B), thus preventing the flow of current through the external load, R_L.

The waveforms associated with the half-wave rectifier are shown in Fig. 1C. The top waveform is that of the ac sine wave applied to the input, while the bottom waveform shows the rectified pulsating dc output across R_L. Note that the pulsating dc output exists only when the input waveform is in its positive alternation. Because half of the input waveform is not used, the half-wave rectifier is very wasteful of electrical energy. And half-wave rectification presents difficulties in filtering the output to pure dc with no ripple component.

The half-wave rectifier has an average output potential of approximately 0.45 times the applied rms potential and its ripple amounts to 120%. To add to the problems of this design, the transformer used must have a primary VA rating 40% greater than is required if full-wave rectification were used.

A basic full-wave rectifier using a center-tapped transformer is illustrated in Fig. 2A. At any given ac peak, one end of the transformer's secondary is positive, while the other end is negative. The center tap is at a potential that is half that across the entire secondary. Therefore, if the center tap is used as the common reference, equal and opposite polarity potentials will be found at either end of the secondary with respect to the center tap.

Let us consider the case when the top of the secondary is more positive than the bottom. Current flows from the common center tap through R_L and forward-biased rectifier *D1* (whose anode is more positive than its cathode) and then back to the transformer. During this period, *D2* is reverse-biased due to the negative potential at its anode so that no current can flow through it.

On the alternate half-cycle, *D1* becomes reverse-biased and *D2* conducts. Current then flows from the center tap through R_L and forward-biased *D2* and back to the secondary of the transformer. Note that, in both cases, the current flows through the load in the same direction. This produces the "double-humped" waveform across R_L shown in the lower trace of Fig. 2B. In essence, the negative-going portion of the applied ac sine wave has been "folded up" to produce the double-frequency waveform shown in the figure.

The bridge circuit shown in Fig. 3 is another type of full-wave rectifier. It employs a diode "ring" (*D1* through *D4*) for rectification. The secondary of the transformer is not center tapped; the diode ring provides the negative (sometimes ground) reference point. The two "corners" of the bridge labelled "+" and "−" and go to the positive and negative sides of the filter capacitor.

Since the bridge rectifier circuit em-

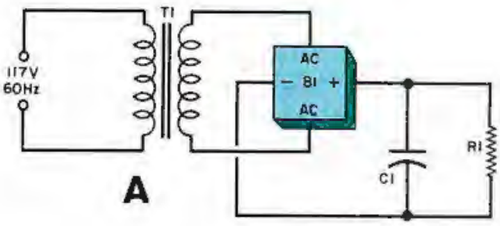
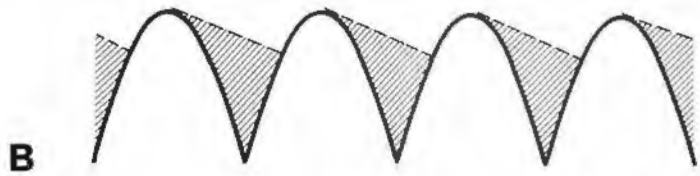


Fig. 4. Simple power supply with capacitance filter (A). Waveforms in (B) show how capacitor fills in between humps to smooth ripple.



ploys the entire secondary potential, it produces an output potential (pulsating dc) of twice that of the ordinary full-wave rectifier using the same transformer. There is one catch, however. The bridge rectifier supply delivers only half the current of the full-wave rectifier for a given primary VA rating. There are occasions when it is possible to exceed this and draw nearly the full rated current from the transformer's secondary without causing damage, but this is not dependable in all cases.

The average dc output potential in an unfiltered full-wave supply is approximately 0.9 times the applied rms potential, or about twice the voltage obtained with the half-wave rectifier. Both types of full-wave rectifiers have an output ripple component of about 48% and, thus, need filtering to produce the dc required by the electronic circuits. Also, the ripple frequency in the full-wave rectifier circuit is 120 Hz, which is twice the frequency of the line power.

Filters. The filter smoothes out the pulsating dc output from the rectifier to create the nearly pure dc required by the electronic circuitry load.

The half-wave rectifier produces one dc pulse for each ac cycle (Fig. 1C), while the full-wave supply produces two dc pulses per cycle (Fig. 2B). These waveforms illustrate the difference in ripple frequency—60 Hz for the half-wave and 120-Hz for the full-wave rectifiers—and implies that the higher frequency of the half-wave rectifier's output is easier to filter.

The usual high-value capacitor found in power supplies is shown in Fig. 4A. In this circuit, the bridge rectifier is shown in block form, since it is most often a bridge-rectifier assembly rather than a set of four discrete rectifier diodes. Filter capacitor *C1* is connected directly across the rectifier.

The value of *C1* is critical to the performance of the power supply. It should be no less than 1000 μF per ampere of output current; many authorities claim that 2000 μF per ampere should be the minimum. In any event, it is good practice to use not less than 1000 μF in projects that draw 1 ampere or less current. A typical 5-volt, 4-ampere dc power supply for a small digital computer would require not less than 8000 microfarads for a good filtering.

The waveform shown in Fig. 4B illustrates how the filter capacitor reduces the level of the pulsations in the rectified output waveform. Capacitor *C1* charges up as long as the pulsating dc applied to it is rising. Once the peak potential has been reached and the rectified waveform begins to drop toward zero, the capacitor dumps its charge to fill up the spaces (shaded area in Fig. 4B) between the pulses. Obviously, the greater the charge dumped, the smoother will be the top of the output waveform from the filter. The five waveforms shown in Fig. 5 were obtained from a low-voltage, 5-ampere supply using different amounts of filter capacitance. The circuit employed was that shown in Fig. 4, using a transformer rated at 13 volts and 10 amperes.

The Fig. 5A waveform shows the unfiltered output across the load resistor. The base line represents the 0-volt level, while the peak of the pulsating dc waveform is just short of 19 volts. The result of connecting a 150-μF capacitor across the load is shown in Fig. 5B. Note that the ripple has been reduced and has taken the shape of the filtered output shown in Fig. 4B. A dc voltmeter connected across the load indicated approximately 13 volts when there was

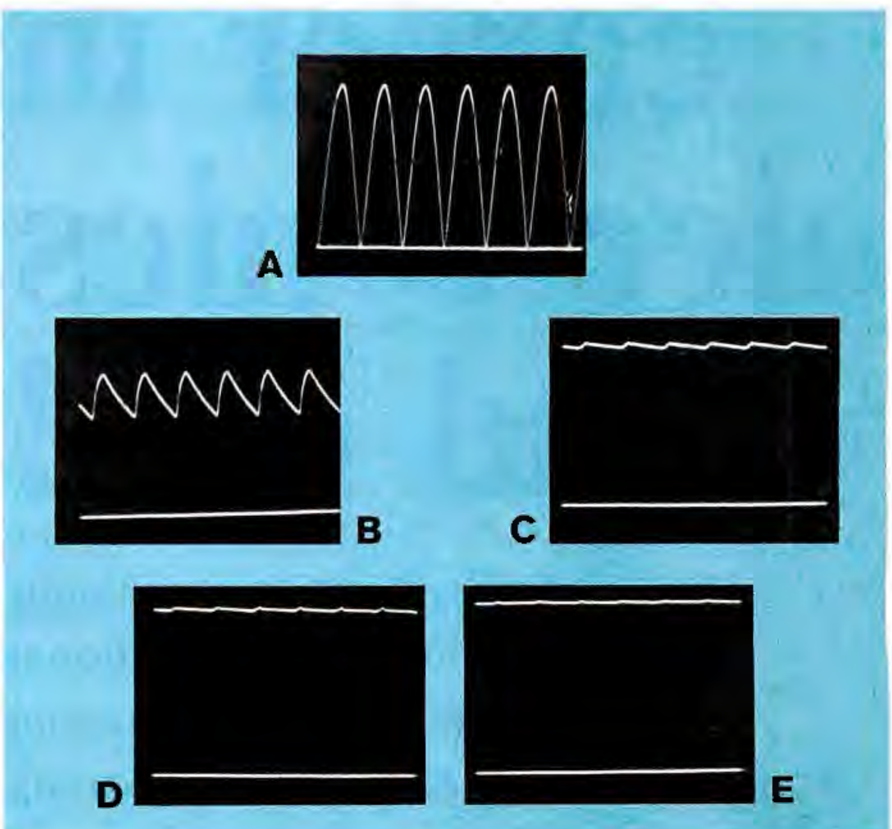


Fig. 5. How capacitors smooth waveform. Lower trace is zero volts. (A) is full-wave dc without filter; (B) has 150-μF capacitor; (C) 2000 μF; (D) 5000 μF; (E) 18,000 μF.

If you can't go to college for your career in electronics -read this!

CREI brings college-level training to you with eight educational advantages, including special arrangements for engineering degrees

The best way to qualify for top positions and top pay in electronics is obviously with college-level training. The person with such training usually steps more quickly into an engineering level position and is paid considerably more than the average technician who has been on the job several years.

A regular college engineering program, however, means several years of full-time resident training—and it often means waiting several years before *you can even start your career.* This, of course, is difficult if you must work full time to support yourself and your family.

If your career in electronics is limited without college-level training, take a look at the advantages a CREI home study program can offer you.

1. Convenient Training

CREI brings the college to you. Through the convenience of home study, you receive exactly the same level of training you will find in any college or university offering programs in electronic engineering technology. With CREI, however, you can "go to college" whenever you have spare time at home or on the job.

2. Specialized Programs

With CREI, you enjoy the advantage of *specialized* training. That is, your program will include only those courses directly applicable to your career in electronics. We omit such courses as English, social studies and other subjects, which are usually required in resident schools. Therefore, with CREI, you move ahead faster to the more interesting and useful part of your training.

3. Practical Engineering

CREI programs give you a *practical engineering* knowledge of electronics. That is, each part of your training is planned for your "use on the job." By using your training, you reinforce the learning process. And by demonstrating your increased knowledge to your employer, you may qualify for faster career advancement.

4. Engineering Degrees

CREI offers you a number of special arrangements for earning engineering degrees at recognized colleges and universities. You can earn college credit while you are taking your CREI program or apply later, whatever is best for your career plans.

Career Training at Home

5. Unique Laboratory
Only CREI offers you the unique Electronic Design Laboratory Program. This complete college laboratory makes learning advanced electronics easier and it gives you extensive practical experience in many areas of engineering, including design of electronic circuits. No other school offers this unique program. It is a better "Lab" than we have found in many colleges. And the professional equipment included in the program becomes yours to keep and use throughout your professional career.

6. Wide Program Choice
CREI gives you a choice of specialization in 14 areas of electronics. You can select exactly the area of electronics best for your career field. You can specialize in such areas as computer electronics, communications engineering, microwave, CATV, television (broadcast) engineering and many other areas of modern electronics.

7. Prepared by Experts
Experts in industry and technical organizations of government develop CREI programs. Each part of your training is developed by a recognized expert in that area of electronics. That means you get the most up-to-date and practical instruction for your career.

8. Industry Recognition
That CREI training is recognized by industry and government is evident from the fact CREI provides training to advanced technical personnel in over 1,700 technical organizations. Many subsidize the training of their employees with CREI. If there is any question about the advantages of CREI training for you, ask your employer or any engineer to evaluate the outline of a CREI program for you.

Other Advantages
Of course, there are many other advantages to CREI training. For example, throughout your training, CREI's staff gives you personal instruction for each step of your program. And in many industrial areas, both in the U. S. and abroad, CREI Field Service Representatives provide a number of important personal services for your training and your career.

FREE Book
There isn't room here to give you all of the facts about career opportunities in advanced electronics and how CREI prepares you for them. So we invite you to send for our free catalog (if you are qualified). This fully illustrated, 80 page catalog describes in detail the programs, equipment and services of CREI.

Qualifications
You may be eligible to take a CREI college-level program in electronics if you are a high school graduate (or the true equivalent) and have previous training or experience in electronics. Program arrangements are available depending upon whether you have extensive or minimum experience in electronics.

Send for this FREE Book describing your opportunities and CREI college-level programs in electronics

Mail card or write describing qualifications to

CREI
CAPITOL RADIO ENGINEERING INSTITUTE

McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue Northwest
Washington, D.C. 20016

Accredited Member National Home Study Council

GI Bill
CREI programs are approved for training of veterans and servicemen under the G.I. Bill.

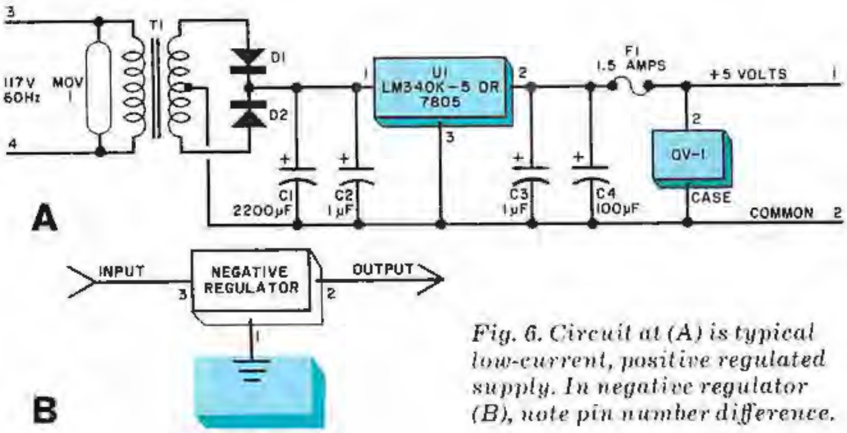


Fig. 6. Circuit at (A) is typical low-current, positive regulated supply. In negative regulator (B), note pin number difference.

no filtering. With the 150-µF capacitor installed, it indicated 16.8 volts.

Connecting a 2000-µF capacitor across the load produced the Fig. 5C waveform. The ripple is substantially reduced and the average dc potential has risen to about 18 volts. The situation is even better in Fig. 5D, where the capacitance is 5000 µF. The ripple has lessened to the point of almost disappearing. The dc potential has risen only an additional 0.7 volt, to 18.7 volts. In the Fig. 5E waveform, an 18,000-µF capacitor is across the load, which results in less ripple but no increase in the dc output potential. Bear in mind that this is for a 4-ampere power supply in which the formula capacitance should have been 8000 picofarads.

Voltage Regulators. Circuits that maintain their output potential constant over a wide range of load variations are termed "voltage regulators." Most computers and all TTL circuits fare better on such regulated power supplies.

Voltage regulators for low-current levels are reasonably simple. Up to 5 amperes, conventional low-cost three-terminal IC regulators can be used. The circuit of a power supply in which a three-terminal regulator is used is shown in Fig. 6A.

Several different but essentially similar families of three-terminal IC regulators exist. Probably the most familiar is the LM309 series, the LM309H being a 100-mA device in a TO-5 package and the LM309K a 1-ampere device in a TO-3 case.

There is also the LM340 series in which the output voltage is indicated by a number suffix added to the basic series number. For example, the LM340-5 is a 5-volt regulator, while the LM340-12 is a 12-volt device. These devices are available with outputs up to 24 volts. They come in two package styles—the K package for 1-ampere and the T package for 750-mA capacity.

The LM320 devices are essentially the same as the LM340 devices, except that they are designed for negative output voltages. Note that the pinouts for the negative regulator shown in Fig. 6B are different than for the positive regulator. Failure to observe this fact can result in catastrophic damage when the power supply is turned on.

Another well-known regulator family is the 7800 (positive) and 7900 (negative) series. The output potential is given by the last two digits in the type number (7805 for +5 volts and 7812 for +12 volts output, for example).

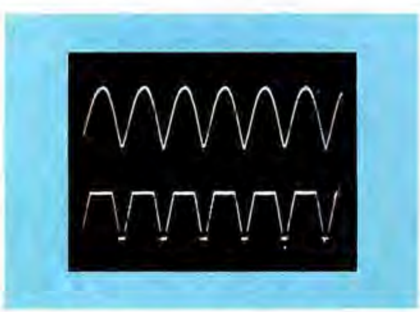


Fig. 7. Bottom waveform shows how a regulator "limits" peaks on rectified pulsating dc.

As shown in Fig. 6A, all three-terminal regulators should have noise bypass capacitors (*C2* and *C3*) across their input and output terminals. Various manufacturers specify different values for these bypass capacitors, the most common being between 0.33 and 2 µF. These noise filters should be wired as close to the terminals of the regulator as possible. If you use the lower value, the capacitor should be of ceramic disc construction. If the higher value is used, select a tantalum capacitor.

Capacitor *C4* is optional but desirable, especially where output current demands are very dynamic. The capacitance usually specified is on the order of 100 µF per ampere, or about a tenth of the value of the main filter capacitor. This added capacitor is not specifically used for filtering but to provide a "hedge" against output voltage droop under transient load conditions.

It is necessary to use a filter capacitor before a regulator; and Fig. 7 reveals why. The upper trace is the pulsating dc obtained from the rectifier, while the lower trace is the output of the regulator when filter capacitor *C1* is disconnected from the circuit. The unfiltered but regulated output waveform rises in each cycle until it reaches the cutoff point of the regulator, at which point it clips. Now, examine the waveform shown in Fig. 8. Although these waveforms appear to be similar to those shown in Fig. 5, they are different. In Fig. 5, the lower trace was used to indicate the 0-volt base line, while in Fig. 8 they illustrate the input (upper) and output (lower) of a three-terminal regulator. These traces are ac-coupled to the oscilloscope so that the dc component is suppressed and to permit the 5000-µF ripple component to be shown on a larger scale. The preregulation waveform of the upper trace was taken using a 0.2-volt/cm sensitivity in the scope's vertical channel, while a 0.01-volt/cm sensitivity was used for the lower trace. Even at 20 times sensitivity, no apparent ripple appears in the output waveform on the scope.

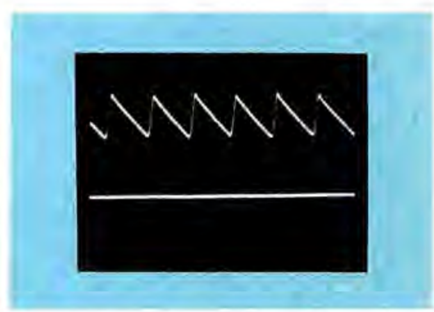


Fig. 8. Waveform at top is before regulator. Lower trace shows how ripple is eliminated.

Overvoltage Protection. Unfortunately, there are occasions when "something happens" in the regulator that permits the output voltage to rise above the required level. This potentially disastrous situation can be averted with an overvoltage protection circuit like that shown in Fig. 9. This circuit is called a

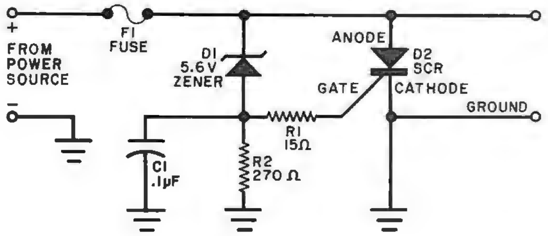


Fig. 9. Crowbar overvoltage protection circuit "fires" when 5-volt line exceeds breakdown voltage of zener diode.

"crowbar" because it operates by shorting the output to ground in the same manner as a conducting metal crowbar would if it were actually connected across the supply.

Normally, the supply potential (in this case +5 volts) is too low to allow zener diode *D1* to conduct. Consequently, the SCR presents a high impedance that makes it "invisible" to the dc line. When the potential on the supply line exceeds 5.6 volts, *D1* conducts and generates a voltage across *R2*. This voltage is then applied, via *R1*, to the gate of the SCR, which triggers on. When this occurs, the short circuit that results causes fuse *F1* to blow and shut down power. Although this circuit appears to be a little crude, it is extremely effective and can prevent damage to an expensive system connected to the power supply.

If you decide to use the crowbar protection circuit shown in Fig. 9, select an SCR that can handle about twice the current normally delivered by the power supply. Also, use a conventional fast-blow fuse for *F1*.

Some of the circuits we will discuss in Part II employ commercially available overvoltage protection devices, such as the OV-1 shown in Fig. 6A.

Current Limiting. This feature is usually found in supplies that employ more sophisticated voltage regulator circuits than those described above. Essentially, a small-value resistor is connected in series with the output lead of the regulator and the current drawn by the load generates a small voltage drop across this resistor. This voltage is applied to a comparator/amplifier that shuts down the power supply if excess current is drawn by the load.

Coming Up. In Part II of this article, we will discuss further design criteria. We will also present four construction projects: a +8-volt, 15-ampere power supply for Altair (S-100) bus microcomputers; +5-volt, 4-ampere power supply; ±12-volt, 1-ampere power supply; and a sophisticated 5-volt, 10-ampere power supply with overvoltage protection and current-limiting shutdown. ◇

BY FORREST M. MIMS

Micro-PROCESSOR MICROCOURSE

PART 2. BASIC DIGITAL LOGIC

The Basic Logic Gates. All digital logic circuits, from the simplest counter to the most sophisticated microprocessor, are made from interconnected combinations of simple building-block circuits called logic gates. There are four basic gates, and they are designated according to their function as YES, NOT, AND, and OR circuits. Each of these basic gates has one or more inputs, a single output, and a couple of power supply terminals.

Various combinations of the binary bits 0 and 1 can be applied to the inputs of a gate by allowing a low voltage to represent logic 0 and a high voltage logic 1. This is called positive logic. In negative logic, the definitions are reversed.

The YES gate transmits the logic state (0 or 1) at its single input directly to its output. It's often used to interface logic circuits that are otherwise electronically incompatible. For this reason it's often called a *buffer*.

The NOT gate inverts or complements the logic state at its single input so it's often called an inverter. The NOT function is often indicated by a bar or vinculum over the symbol for an input or output that's been inverted. Thus if A is 0 and B is 1, then $A = \overline{B}$. (The $\overline{B}$ is read and sometimes written "not B.")

The AND gate is a decision making circuit with two or more inputs. The output of the AND gate is logic 0 unless *all* the inputs (inputs A *and* B *and* C . . .) are logic 1.

The OR gate is also a decision making circuit with two or more inputs. Its output is logic 0 unless *any* or *all* of its inputs (input A *or* B *or* C . . .) are 1.

The operation of a gate can be defined by a table that shows the combination of input bits that produces a particular output bit. Such a table is called a truth table. The truth tables and standard symbols for each of the four basic logic gates are shown in Fig. 1.

Compound Logic Circuits. Combining two or more of the basic gates into a compound logic circuit can provide some very important operating features. The two most important compound logic circuits are the AND-NOT and OR-NOT combinations. These are called the NAND and NOR gates and their symbols and truth tables are shown in Fig. 2.

As shown in Fig. 3, various combinations of NAND (or NOR) gates *alone* can simulate YES, NOT, and AND circuits. This is important, but the most fascinating characteristic of the NAND and NOR functions is their logic equivalence. Thanks to a rule known as DeMorgan's theorem, a positive logic NAND gate is equivalent to a negative logic NOR gate and vice versa.

You can prove this for yourself by writing the appropriate truth tables and finding that they are indeed identical. DeMorgan's theorem simplifies digital logic to the point where combinations of only NAND gates or NOR gates can implement any logic function. Figure 4, for example, shows how NAND gates alone can implement both the OR and NOR functions. Notice how NAND gates are used as inverters to change the inputs from positive to negative logic.

Complex Logic Systems. Simple and compound gates can be tied together to implement a countless variety of logic functions. Some of the resulting logic systems contain only a handful of gates; others may use dozens or even hundreds of gates. All of these complex logic systems can be divided into two broad categories: combinational and sequential.

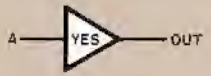
Combinational circuits are characterized by their fast acting operation. Exclusive of the brief time delay required for its gates to react to an incoming logic 0 or 1 (the propagation time), the output(s) of the most complex combinational circuit instantaneously reflects the pattern of 0's and 1's at its input(s).

Sequential circuits include storage or delay elements that permit the logic result of a previous input to directly influence a new input. This makes sequential circuits slower than combinational circuits. But it also makes possible important applications such as memory registers, counters, dividers, sequencers, and microprocessors.

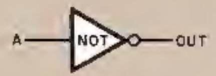
Combinational Logic Circuits. The simplest combinational logic circuit is the Exclusive-OR gate. The symbol and truth table for this circuit are shown in Fig. 5.

Look at the Exclusive-OR truth table for a moment. The Exclusive-OR function is just that; it gives a logic 1 output *only* if one *or* the other of its two inputs is logic 1. Otherwise the output is 0. This is identical to the binary addition rules with the exception of the carry output needed for 1 + 1.

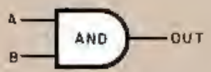
It's easy to generate the carry output bit needed to use the Exclusive-OR circuit as a binary adder. Look at the logic



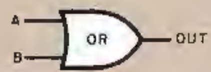
A	OUT
0	0
1	1



A	OUT
0	1
1	0



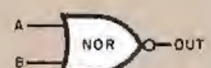
A	B	OUT
0	0	0
0	1	0
1	0	0
1	1	1



A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	1

Fig. 1. The four basic logic gates: YES, NOT, AND, OR.

A	B	OUT
0	0	1
0	1	1
1	0	1
1	1	0



A	B	OUT
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 2. A NAND gate and a NOR gate, with their repective truth tables below.

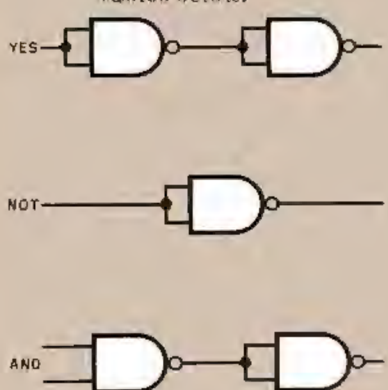


Fig. 3. Using NAND gates to simulate other gates. At top, YES; middle, NOT; bottom, AND.

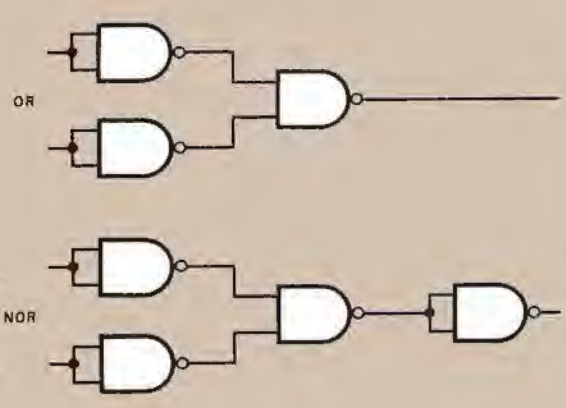


Fig. 4. Using NAND gates to prove DeMorgan's theorem. At top, OR; on the bottom, NOR.

circuit for an Exclusive-OR in Fig. 6. If you'll study the operation of this circuit, you'll find that the output of AND gate 1 provides the carry output we need. In the other circuit in Fig. 6, we use this carry output to form a circuit that can add any two binary bits. It's known as a *half adder.*

A half adder is useful, but it can only accept two input bits. To complete the binary addition rules, we need an adder circuit that will accept a carry bit as well. The circuit that accomplishes this goal is the *full adder.* As you can see in Fig. 7, a full adder can be made from two half adders and an OR gate.

It's possible to connect a string of adders together to form a binary adder capable of adding multiple-bit binary words. Figure 8, for instance, shows a 4-bit adder that will sum two words applied to its inputs. Try adding 1101 + 0101 using this adder to prove to yourself it really adds.

A binary adder forms part of a microprocessor's arithmetic-logic unit (ALU), a combinational circuit that performs addition, subtraction, and various logic operations upon two incoming words. The ALU is instructed what operations it is to perform by binary signals applied to its control inputs. We'll learn more about the ALU later in this course.

Encoders and Decoders. An encoder is a combinational network of OR gates that converts or encodes a nonbinary input into binary. For example, an octal-to-binary encoder has eight inputs (one for each octal digit) and three outputs (one for each binary bit). A logic 1 at one of the inputs produces the binary equivalent at the output.

Encoders can provide other conversion operations, too. Keyboard encoders, for instance, convert individual key positions into their assigned binary words. An example is the ASCII (American Standard Code for Information Interchange) encoded keyboard, which generates the 7-bit word 0100101 when the % key is pressed.

A decoder is a combinational circuit that converts a binary number at its inputs into a logic 1 at one or more of its outputs. In digital electronics it's often necessary to convert a binary number into some other format, and one common decoder application is the conversion of binary numbers into the format required to activate the appropriate segments in a 7-segment decimal display.

Decoders are also used to decode binary instructions in a microprocessor,

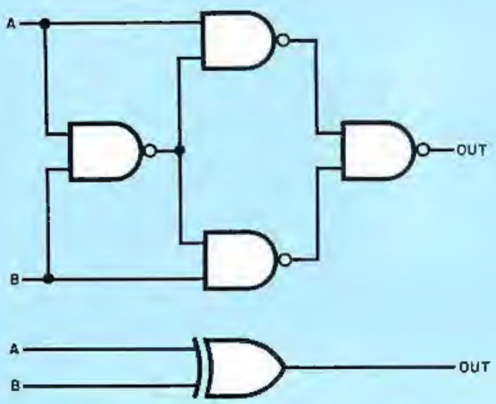


Fig. 5. The combinational circuit at top provides an Exclusive-OR, as shown in the middle. The truth table is below.

A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	0

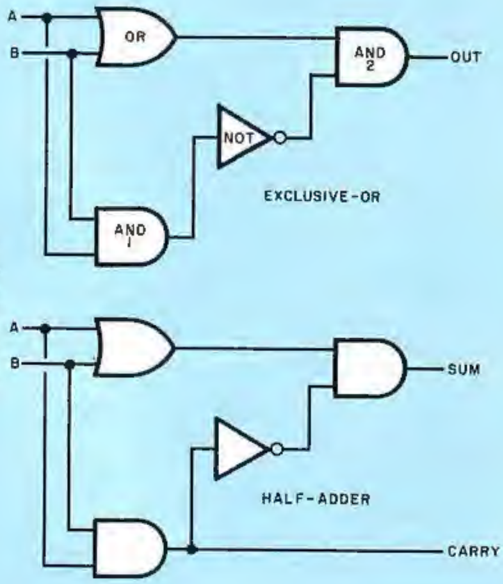


Fig. 6. How an Exclusive-OR can be used to make a half-adder combinational circuit.

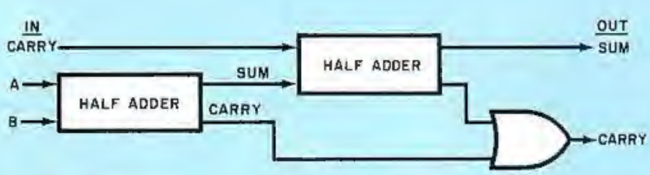


Fig. 7. Two half adders and an OR gate can be used to make a full adder circuit.

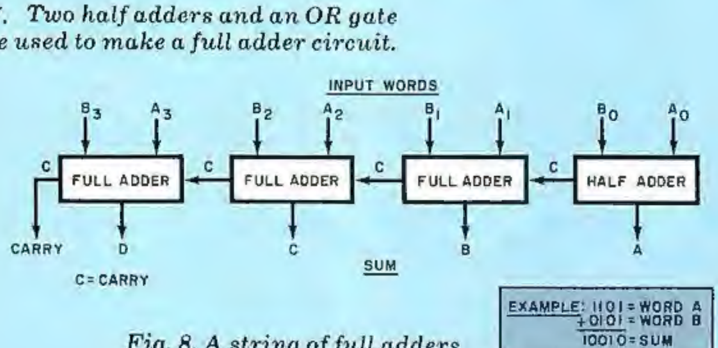


Fig. 8. A string of full adders connected together can be used to form a binary adder, capable of adding binary words.

assist in the production of sequential timing signals for advanced logic circuits, and convert binary numbers into their octal, decimal, and hexadecimal counterparts. Figure 9 summarizes the operation of encoders and decoders.

Multiplexers and Demultiplexers. The multiplexer is the digital logic equivalent of a multiple-position rotary switch. A typical multiplexer is a combinational logic circuit that selects one of several input lines and applies any data on that line to a single output. A special set of address inputs determines which input line is selected.

One typical multiplexer has eight data inputs, three address inputs, and a single data output. When the address 101 is applied to the multiplexer, input 5 is connected to the output.

A common application for multiplexers is driving the readouts of pocket calculators to reduce the number of pin connections on the calculator's chip. The multiplexer lets all the digits in the readout share a common set of terminals. It activates each digit or one segment in all the digits in rapid succession to fool the eye into thinking the display is continually illuminated.

The demultiplexer transfers the binary data at its input onto one of two or more output lines. Like the multiplexer, an address input controls the output.

Demultiplexers are used with multiplexers to convert multiplexed data back to its original form. They can even function as decoders by applying a logic 1 to the single input and using the address inputs as data inputs. Figure 10 summarizes the operation of multiplexers and demultiplexers.

Sequential Logic Circuits. Unlike combinational logic circuits, sequential circuits have memory. Their output(s) can reflect the effect of an input that occurred seconds or even days earlier.

The simplest sequential circuit is the flip-flop. A microprocessor together with a read/write memory incorporates dozens—perhaps thousands—of flip-flops.

There are several different kinds of flip-flops, but all are capable of storing a single binary bit. This makes possible such applications as counters, dividers, memory registers, and others. Here are the four basic kinds of flip-flops.

The RS Flip-Flop. The simplest flip-flop is made from two NAND or NOR gates with crisscrossed inputs and outputs as shown in Figure 11. This basic circuit is called a reset-set (RS) flip-flop

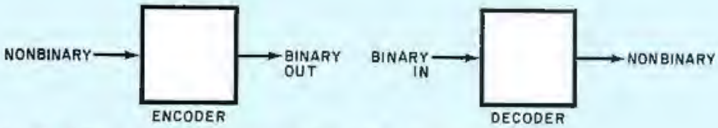
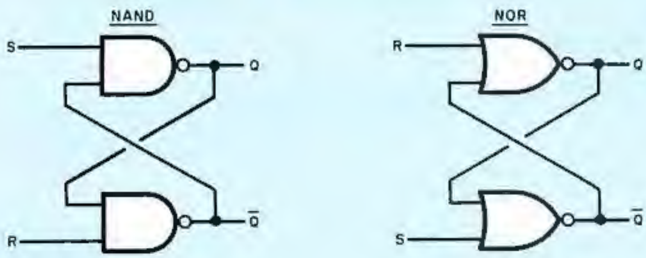


Fig. 9. An encoder is a combinational network that converts a nonbinary input to a binary output. A decoder does just the reverse.

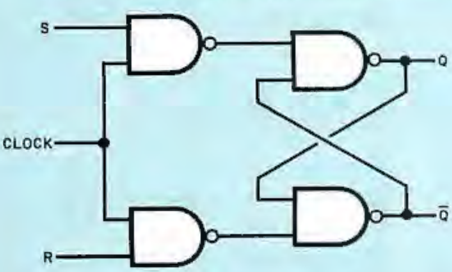
Fig. 10. A multiplexer is the equivalent of a multiple-position switch. A demultiplexer converts multiplexed data back to original form.



S	R	Q	$\overline{Q}$
0	0	NOT ALLOWED	
0	1	1	0
1	0	0	1
1	1	NO CHANGE	

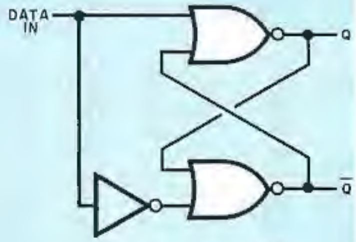
S	R	Q	$\overline{Q}$
0	0	NO CHANGE	
0	1	0	1
1	0	1	0
1	1	NOT ALLOWED	

Fig. 11. Simplest flip-flop is made from two NAND's or two NOR's with truth tables as shown.



CLOCK	S	R	Q	$\overline{Q}$
0	0	1	NO CHANGE	
0	1	0	NO CHANGE	
1	0	1	1	0
1	1	0	0	1

Fig. 12. A clocked RS flip-flop is a sequential circuit with truth table as shown here.



D	Q	$\overline{Q}$
0	0	1
1	1	0

Fig. 13. A data, or D, flip-flop is made by adding an inverter to input of one flip-flop.

or simply a *latch*. Figure 11 also shows the truth tables for NAND and NOR gate versions of the RS flip-flop.

Notice that the two outputs of the RS flip-flop complement one another. When Q is logic 1, the flip-flop is *set*. When Q is logic 0, the flip-flop is *reset* or *cleared*.

Clocked RS Flip-Flop. The basic RS flip-flop is *asynchronous*; it responds to inputs as soon as they occur. A way to synchronize the operation of the RS flip-flop with other logic circuits is to gate its inputs so they can respond only when activated by a logic 1 from a *clock*. A clock is a sequential circuit that produces a stream of alternating 0's and 1's. Fig. 12 is a clocked RS flip-flop.

The Data or D Flip-Flop. The D flip-flop is a further modification of the clocked RS flip-flop. As shown in Figure 13, an inverter is added to one of the two inputs of the flip-flop and the remaining input and the inverter's input are tied together. This guarantees that the inputs to the RS section of the flip-flop will always complement one another. And it insures that the logic state of the Q output will always correspond to the logic state of the D input.

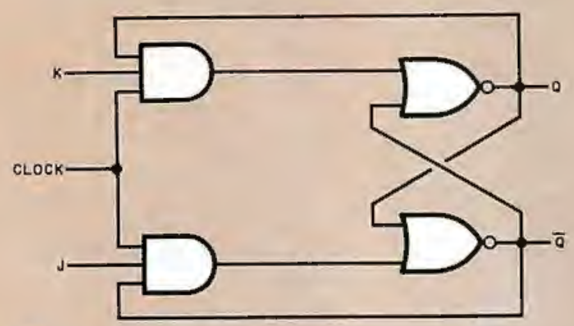
The JK Flip-Flop. The JK flip-flop is a clocked RS flip-flop with a refinement that allows a logic 1 to be simultaneously applied to both inputs. Figure 14 shows the logic circuit and truth table for this flip-flop. The JK flip-flop can easily simulate any of the other kinds of flip-flops, so it's commonly used in sequential logic circuits.

The JK flip-flop can be used to make a toggle or T flip-flop. The J and K inputs are tied together and called the T input. When a logic 1 is applied to T, the flip-flop changes state or toggles each time a clock pulse arrives.

Storage Registers. A string of D flip-flops called a *register* can be used to store a binary word. A register like this can be made far more useful by adding some combinational logic to simultaneously clear all the flip-flops to 0 when a logic 1 is applied to a *clear* input. A *load* input can also be added to force the register to ignore incoming data. When the load input is logic 1, the input data will be accepted by the register when the next clock pulse arrives.

Data storage registers like this are sometimes called *buffer* registers. They're used in logic circuits and in microprocessor units to temporarily hold a data word.

Shift Registers. Considerably more



Q=0

J	K	Q*
0	0	0
0	1	0
1	0	1
1	1	1

*(after clock pulse)

Q=1

J	K	Q*
0	0	1
0	1	0
1	0	1
1	1	0

*(after clock pulse)

Fig. 14. The JK flip-flop is a clocked RS flip-flop that allows a logic 1 to be simultaneously applied to both inputs. Shown here is a NOR gate version with truth tables for $Q = 0$ and $Q = 1$.

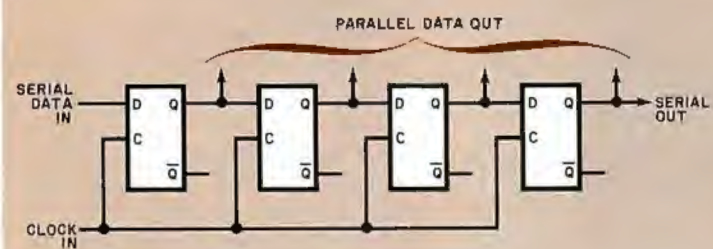


Fig. 15. This shift register made from D flip-flops accepts data a bit at a time and has a serial output as well as parallel outputs from each flip-flop.

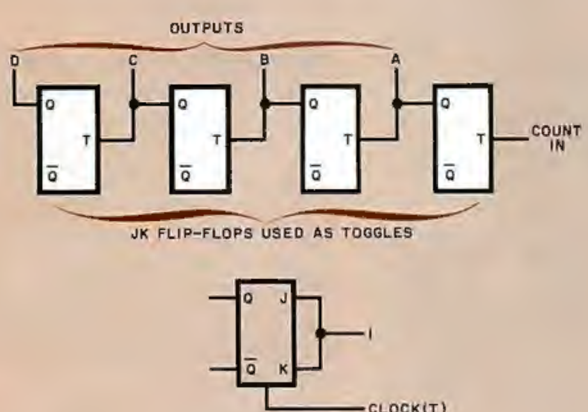


Fig. 16. A four-bit counter made from T flip-flops that will count from 0000 to 1111 and then recycle.

versatile than the buffer register is the shift register shown in Fig. 15. This particular register accepts data a bit at a time (serial input) while making available the contents of all its flip-flops simultaneously (parallel output). The data bits in the register are shifted right a bit at a time by clock pulses to make room for incoming bits.

Universal shift registers that can accept and output data as serial bits or parallel words as well as shift the data left or right are available. The various operations of a universal shift register are selected by applying logical 0's and 1's to an array of control inputs. Microprocessors incorporate at least one shift register to perform some of the data manipulation required to multiply and divide binary numbers.

Counters. Remember the toggle or T flip-flop we discussed earlier? The Q output of this flip-flop alternates between logic 0 and 1 for each incoming clock pulse: 0 . . . 1 . . . 0. . . 1 . . . In other words, the Q output is logic 1 for *half* the incoming clock pulses. This means a single flip-flop can be used to divide an incoming stream of bits by two. The Q output of a toggle flip-flop also counts! Thus, 0 . . . 1 . . . 0 . . . 1 . . . is the same as counting from 0 to 1 in binary over and over again.

Higher capacity binary counters (and dividers) can be made from a string of T flip-flops. Just connect the Q output of one flip-flop to the clock input of the next flip-flop. Figure 16, for instance, shows a 4-bit counter made from four T flip-flops. This counter will count from 0000 to 1111 and then recycle.

There are many different kinds of flip-flop counters. The *modulo* of a counter specifies the maximum count it reaches before recycling. Modulo 10 counters are very popular because they recycle after the tenth input pulse and therefore provide a convenient way to count in decimal. They are often called BCD (*b*inary *c*oded *d*ecimal) counters. Their count sequence is 0000 (0_{10}) . . . 0001 (1_{10}) . . . 0010 (2_{10}) . . . . . . 1001 (9_{10}) . . . 0000 (0_{10}) . . . .

Counters can have a variety of control inputs. A typical counter, for example, can count up *or* down. It may also have control inputs for clearing the count to all 0's, presetting the count to any desired value, and enabling the counter to count. Finally, since counters store the accumulated count until the next clock pulse arrives, they can be considered storage registers. ◇

how electronic music synthesizers work

BY JOHN S. SIMONTON, JR.

Examines noise generators, instrument dynamics, and voltage control.

THE ELECTRONIC music synthesizer has changed the face of recorded music and live rock-band performances. This "instrument" can produce a myriad of unconventional, sometimes weird or eerie sounds. Yet it can also emulate the sounds of any conventional instrument.

There are two basic types of synthesizers: studio and performance. Modern studio synthesizers are made up of modular sections that consist of voltage-controlled amplifiers, filters, oscillators and noise generators, modulators and other devices. These modules can be interconnected in virtually any order by plugging their inputs and outputs together with "patch" cords. The output of almost any given module can be used either as part of the tone you eventually hear, or as the control voltage for another module. It all depends on how one "patches" the elements together.

Synthesizers designed for live performances do not use patch cords, as the time lost in changing patches during a performance would ruin the musical continuity. Here, the various modules are hard-wired together and the sounds are changed by a host of conveniently located switches and potentiometers, used much as stops are on an organ. Since a player can handle only a limited number of controls efficiently, performance synthesizers can't be made as flexible as the studio type.

How It Works. A synthesizer's output waveforms and control signals can be considered as a vast kit of parts from which musicians can assemble any desired sounds. The different parameters of each note—pitch, overtone structure, attack time, duration, and decay—are, in conventional instruments, fixed within narrow limits. In the synthesizer these parameters are independently, and almost infinitely, variable.

The modules that control those parameters are shown in Fig. 1. Pitch and overtones are controlled by the voltage-controlled oscillator (vco) and by the voltage-controlled filter (vcf). The note's attack, sustain, decay and release—its "envelope" in time—are controlled by the voltage-controlled amplifier (vca), which in turn is controlled by the envelope generator. The latter is sometimes called ADSR, the initials of the four parameters it governs—attack, delay, sustain and release. The musician's control input for these modules is usually a keyboard.

Normally, pitch is governed by the voltage-controlled oscillator. As the name implies, its frequency varies with the control voltage fed to it. But the vco also has an effect on overtone structure, or timbre. Its output can, on most synthesizers, be a pure sine wave, with no overtones at all, or a ramp, triangle, pulse, or square wave (see illustrations in Fig. 2), each of which has a different mixture of overtones.

Conventional instruments have somewhat similar overtone structures. A violin note, for instance, begins as a ramp waveform, the bow grabbing the string and deflecting it until the string's tension overcomes the friction of the bow, and the string snaps back again. A saxophone reed's opening and closing makes the equivalent of a square wave.

Don't think that these waveforms fully represent the sound of the instrument. They don't. The actual sound produced depends on the instrument's resonances, which accentuate or attenuate

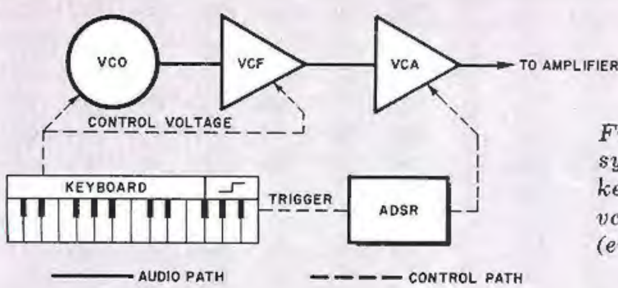


Fig. 1. "Classic" synthesizer consists of keyboard controller, vco, vcf, vca, ADSR (envelope generator).

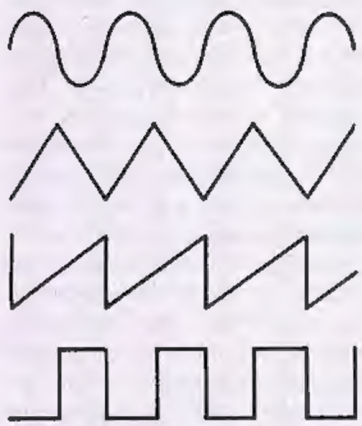


Fig. 2. Typical vco waveforms.

Fig. 3. Filter modifies timbre.

individual harmonic components in the raw waveform. The sound of a saxophone may begin as a square wave, but after passing through the instrument, it appears rather like the "ringing" waveform shown in Fig. 3.

The synthesizer's voltage-controlled filter has a similar effect to that of the saxophone's bell or the violin's hollow body. Whereas the resonators of mechanical instruments are reasonably fixed, a synthesizer's equivalent module (its vcf) can be used as either a low-pass, band-pass or high-pass filter over a frequency range of many octaves, while its "Q" (curve sharpness) is adjustable, too.The vcf can also give pitch to the output of an unpitched signal source, the 'noise generator.' At first it may seem odd to include such a module in a synthesizer, since so much attention is paid to eliminating noise in electronic systems. There are many applications, though, as illustrated in the next section.

The Noise Generator. The noise generator is used in simulating such instruments as the snare drum and the high-hat cymbal, or such natural sounds as wind, surf, explosions and thunderclaps. Using the synthesizer's other resources, it's also possible to create sounds that a real drum or real surf could never make. Let's try, for example, to invent a new musical instrument, with a voice like the wind. With enough experimentation, I'm sure that would sound much like the wind—perhaps a pipe with a plugger of some kind in it. With enough practice, we might even learn how to play it so that we were on pitch (and so that it didn't break into oscillation, which would ruin the effect). But it would take some work.

With a synthesizer, this type of task is almost ridiculously simple. First, we substitute a noise generator for the vco (Fig. 4). Then we recover pitch information from the noise (which contains all possible pitches) by passing it through the filter. To play this new instrument, we apply the keyboard's output voltage to the vcf's control input. Now, each keystroke will shift the filter's frequency range, controlling the pitch of the note.

Since the wind usually builds and dies away slowly, we'll want our instrument to have a slow attack and decay, and to sustain as long as we hold down the key. This is where the attack, delay sustain and release, or envelope generator, comes in.

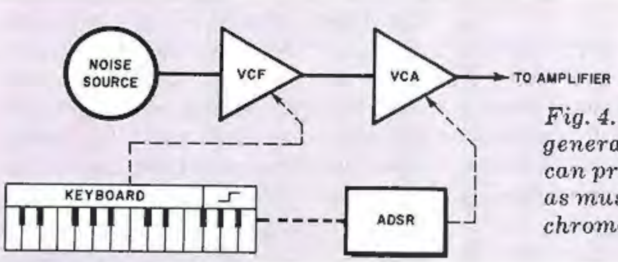


Fig. 4. "Tuning" noise generator output with vcf can produce such affects as musical wind and chromatic high-hat cymbals.

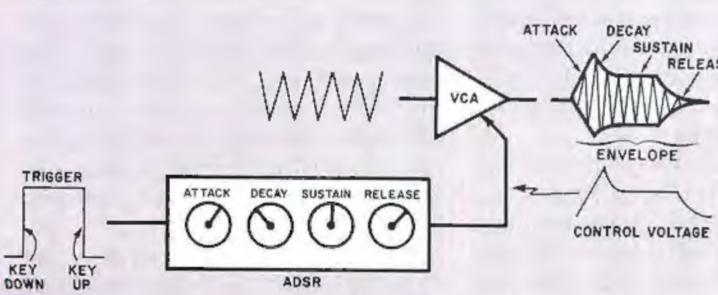


Fig. 5. The combination of a vca and ADSR.

Instrument Dynamics. Every instrument's note varies in amplitude over time. This variation—the instrument's "dynamics"—is one of our chief clues to which instrument we're hearing. (Note how odd most instruments sound when recordings of them are played backwards, even though pitch and overtones are the same.) In some instruments, the sound of each note builds up (attacks) quickly, and dies away (decays) slowly. In others, the attack may be slow, and the decay rapid. Some instruments' outputs begin to die away as soon as a peak is reached; others "sustain" for a time before decay begins.

Though it may not be immediately apparent, all of these characteristics are functions of the way energy is added to each instrument's mechanical system. In instruments where the energy is added all at once (whether by hitting it with a stick or strumming it with a plectrum), the note's volume will be at a peak immediately after striking; and since all of the energy goes in at once, there will be

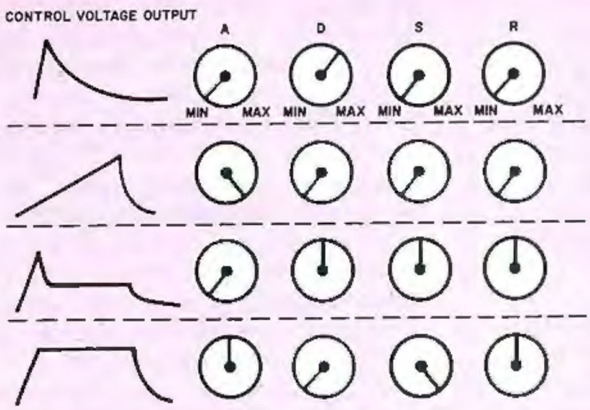


Fig. 6. By varying its ATTACK, DECAY, SUSTAIN *and* RELEASE, *envelope generator can produce different output waveforms.*

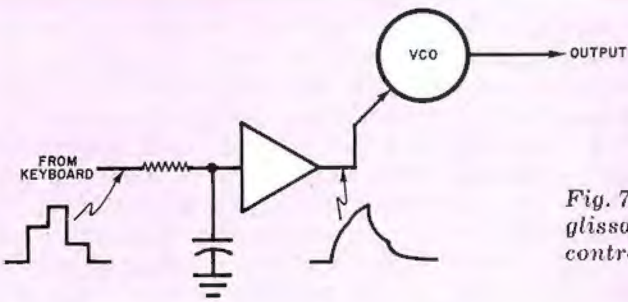


Fig. 7. An integrator adds glissando to a voltage controlled oscillator (vco).

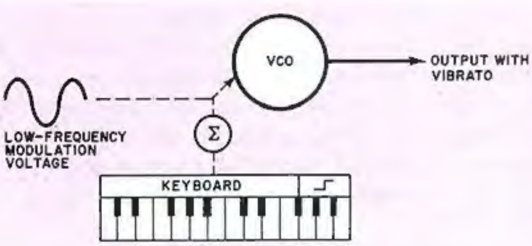


Fig. 8. Summation of control voltages results in special effects like vibrato.

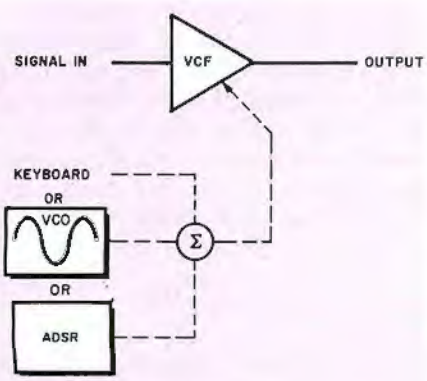


Fig. 9. Varying control voltages from vco or ADSR produce unusual effects.

none left over to sustain the sound—it's downhill all the way until the next note is played. This quick attack and moderate-to-slow decay is typical of instruments in the percussion family: guitar, piano, drums, xylophone, the heads of contestants on the "Gong Show," and such.

It would be natural to assume that we similarly "strike" the oscillator somehow to simulate this type of sound. But natural as this may seem, that's not how it's done. There's an easier way.

In a synthesizer, the oscillator runs all the time. Whether we hear it or not depends on whether the voltage-controlled amplifier (the last element in our "classic" patch) is on or off. And we control the dynamic shape of the note we're building by controlling the rate at which that vca turns on or off.

What controls the vca is the envelope generator or ADSR (Fig. 5). When it receives a trigger signal (usually from the keyboard), the ADSR's control voltage rises to a peak at a rate determined by the setting of the ATTACK control.

After reaching this peak, the control voltage begins to decrease at a rate set by the DECAY control. It doesn't fall all the way back to ZERO, though, just to a level set by a third control, SUSTAIN, where it holds for as long as the original triggering signal is present. Only when the trigger signal goes away (usually when the key on the keyboard is released) does the control voltage fall from the sustaining voltage to zero, and then at a rate set by the RELEASE control.

By adjusting these four controls—ATTACK, SUSTAIN, DECAY and RELEASE—we can cause the ADSR to generate a control voltage which, when used to determine how much signal passes through the vca, simulates the dynamics of any natural instrument (Fig. 6). It can also produce dynamics that would be difficult to produce with a mechanical instrument. An example would be combining the percussive attack of a drum with the sustaining properties of an oboe.

A synthesizer's oscillators and filters operate over an impressively wider frequency range than their mechanical counterparts, and have more modes of operation. A single electronic unit can even simulate a number of properties that might be mutually inconsistent in a mechanical device. But that's only part of the story.

Voltage Control. The real story is voltage control. A synthesizer's oscillator and filter frequencies and amplifier gain are all functions of the control voltages applied. That's more significant than it may look at first.

The keyboards used with most synthesizers are nothing but switch-selectable voltage dividers. Press a key, and a voltage that represents that key appears at the keyboard's output. Press another key and the voltage instantaneously changes to a new level. If the voltage from the keyboard is being used to set the pitch of the oscillator, the output instantly steps from the first note to the second. There will be times, though, when it will be desirable to produce a sound that doesn't instantly change from one pitch to another, but rather glides (glissandos) between notes. Because of voltage control, a simple integrator (nothing more than a register, capacitor and buffer amplifier) placed in the keyboard-to-oscillator control voltage path will produce this effect by slowing down the change (Fig. 7).

Other special effects can be added easily by summing control voltages from several sources. Vibrato, for example, which is a slow-speed modulation, is realized by summing a slowly varying (7–12 Hz) control voltage into one of the

control voltage inputs of the vco (Fig. 8). Applying this same modulating voltage to the vca produces tremolo, a slow variation in the output amplitude.

Since the center or corner frequencies of the filters used are also functions of summed control voltages, several vastly different acoustical instruments can be simulated simply by changing the source of the control voltages that we apply to this element.

If the voltage comes from a fixed source, the output would simulate an instrument with a fixed resonator such as a guitar or piano. However, changing the control voltage allows one to instantly change the properties of the resonator (try *that* with a piano). Moreover, if the control voltage comes from the same source that is supplying pitch information to the oscillators, we can simulate the properties of instruments with variable resonators, such as reed and wind instruments (Fig. 9).

Filter control voltages that vary with time can vary independently of the voltage that controls the oscillator, allowing the filter to sweep the harmonic content of the oscillator's output cyclically (a cross between tremolo and vibrato that is rare among natural instruments). Or, the control voltage can be derived from an ADSR, for a "waa-waa" effect.

Getting back to our "wind" instrument, the desired sighing quality can be easily attained by simply adjusting the envelope generator for a slow attack and decay, a high sustain level, and a slow release. Tiring of that, one need only change the settings of the ADSR to fast attack, no sustain, and moderate decay, to set up an entirely new "instrument." This one will sound like a "chromatic high hat cymbal," one that is played from a keyboard. This would not be only for rhythm, but also as a lead voice in a composition. (Try *that* with your pipe and plugger!) The pitch and range of the filter can be changed, too. Bring an oscillator in, and begin simulating snare drums that can be played in pitch. There's no end to the possible variations achievable with patch-cord type synthesizers.

If you have access to a synthesizer, you'll have instrumental and other sound available for recording right at your fingertips. And if you think that you don't like synthesizer sounds, perhaps you should begin listening more carefully to modern pop, jazz and rock recordings. The next time you hear what appears to be a chorus of violins, read the album's liner notes—they might not be real violins at all! ◇

BY MARTIN SMAHA

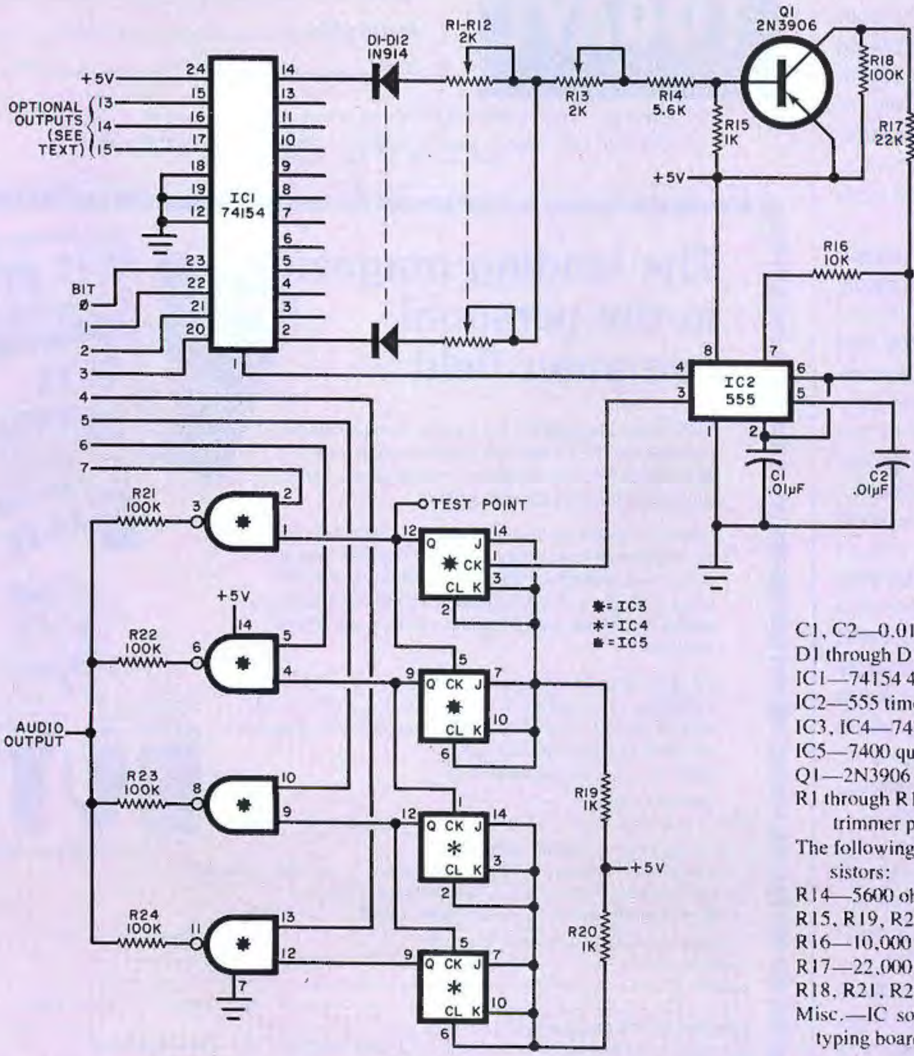
Build a COMPUTER MUSIC BOX PERIPHERAL

Low-cost, 12-tone, 4-octave music generator also produces test signals.

JUDGING from the many commercial plug-ins available, computer-generated music appears to be the "in" thing today. If you have found the single-bit method is too limited and the digital/analog converter approach too expensive, the low-cost (less than $30) Music Box described here may be just for you.

The Music Box has a 12-note, four-octave range. It can be used with any computer that has a parallel output port. And to simplify its use, no strobes or other handshake signals are required.

The Music Box circuit is not limited to making music. It can easily be pro-



As bits 0 through 3 from computer change, the vco changes frequency. Other four bits (4 through 7) determine the octave of the audio output.

PARTS LIST

C1, C2—0.01-µF Mylar capacitor
D1 through D12—1N914 diode
IC1—74154 4-line to 16-line decoder
IC2—555 timer
IC3, IC4—7473 dual JK flip-flop
IC5—7400 quad NAND gate
Q1—2N3906 transistor
R1 through R13—2000-ohm linear-taper pc trimmer potentiometer
The following are 1/4-watt, 5%-tolerance resistors:
R14—5600 ohms
R15, R19, R20—1000 ohms
R16—10,000 ohms
R17—22,000 ohms
R18, R21, R22, R23, R24—100,000 ohms
Misc.—IC sockets (optional); suitable prototyping board; suitable enclosure; etc.

grammed to generate a mix of tones, up to a total of 16, for use as test and remote-control signals.

Circuit Operation. The circuit (see schematic diagram) can be broken down for discussion purposes into three major subsections: note decoder/selector, voltage-controlled oscillator (vco), and octave decoder/selector.

The note decoder/selector consists of integrated circuit *IC1*, a 4-line to 16-line decoder. As the four control bits from the computer (bits 0, 1, 2, and 3) are entered into *IC1*, one of the 16 output lines is driven low. When the output line goes low, it allows its associated diode *(D1* through *D12*) and series potentiometer (*R1* through *R12*) to control the voltage and, hence, the frequency of the vco made up of *IC2*, *Q1*, and their associated components. Since only 12 tones per octave are used in music, output lines 13, 14, and 15 of *IC1* (pins 15, 16, and 17) are not used. (These three lines can be used to control an external device, as we will discuss later.) When *IC1*'s output 0 at pin 1 is low, the vco is cut off to provide a no-note condition.

Timer *IC2* is configured as an oscillator, with transistor *Q1* serving as a voltage-controlled resistor that works in conjunction with frequency-determining capacitor *C1*. By varying the bias applied to the base of *Q1*, the output frequency of the vco system can be made to vary.

Resistor *R18* determines the low- and *R16* and *R17*, the high-frequency ends of the range. Capacitor *C1* can be changed to select the desired frequency range. The output of the oscillator at pin 3 is fed to the flip-flops in *IC3* and *IC4* for octave generation.

The four octaves of square waves generated by *IC3* and *IC4* are summed with the four octave-control bits (bits 4, 5, 6, and 7) by the four AND gates in *IC5*. The resulting selected octaves are mixed in *R21* through *R24* for application to an external audio system. Any combination of four octaves can be selected simply by changing the status of bits 4 through 7. If all octave bits are low, no tone appears at the output. Note that no status signals are required.

Since the audio output consists of square waves, it is not difficult to introduce various types of filters to create different sounds.

Construction. The entire circuit can be assembled on any prototyping board that can be connected to the parallel output port of the computer in which the Music Box is to be used. The power for the Music Box can be taken from the +5-volt and ground lines in the computer. Alternatively, you can use an external power supply rated at 100 mA minimum. In either case, a common ground must be used between the Music Box and computer.

You can use sockets for the IC's if you wish and small board-mounted trimmer potentiometers for *R1* through *R13*.

Calibration. Although the Music Box was designed for use with a computer, it does not require a computer for calibration. All you need is a 5-volt dc power source and an audio system. A frequency counter will simplify calibration but is not a necessity.

Before applying power to the Music Box, set *R1* through *R12* to their maximum series resistance and *R13* to its center of rotation. If you have a frequency counter, connect it to the TEST POINT. Otherwise, connect the output of the Music Box to an amplifier/speaker combination so that the pitch of the output signal can be compared with the sound of a known musical instrument.

Using temporary jumpers to the +5-volt (1) and ground (0) lines, set the control bits to the values given in Table I and adjust the corresponding trimmer potentiometer (*R1* through *R12*) to obtain the indicated frequency (or the correct tone when compared with the sound from a musical instrument). If the entire range cannot be obtained, readjust *R13* and perform the above procedure again.

TABLE I— THE WELL-TEMPERED MUSICAL SCALE

Control bit 76543210	Frequency (Hz)	Note 5th Octave
10000000	0	Off
10000001	523.25	C
0010	554.37	C#
0011	587.33	D
0100	622.25	D#
0101	659.26	E
0110	698.46	E#
0111	739.99	F
1000	783.99	G
1001	830.61	G#
1010	880.00	A
1011	932.33	A#
1100	987.77	B

TABLE II—TEST VALUES

Note	Number value (n)
Off	0
C	1
C#	2
D	3
D#	4
E	5
E#	6
F	7
G	8
G#	9
A	10
A#	11
B	12
Octave	**Number value**
5	n + 128
4	n + 64
3	n + 32
2	n + 16

Note: B_5 is the highest note (n=140)
C_2 is the lowest note (n=17)
C_5 is middle C
A_4 is A_{440}

Operation and Use. Since there is no data latch, the Music Box tracks the data that appears at the parallel output port. Connect the common ground and eight data lines between the Music Box and the output port. To test the system, execute an output of the number value that corresponds to that note as given in Table II.

The software program you write will depend on the music requirements. Arrays can be used to store melody information and loops can be used to control the length of the note.

The four-octave range of the circuit can be shifted by halving the value of *C1* to raise the pitch one octave or it can be doubled to lower the pitch one octave.

Other Uses. The three decoded outputs from *IC1* at pins 15, 16, and 17 can be used to trigger a percussive device (such as the "Cabonga" featured in the August 1977 issue of POPULAR ELECTRONICS) or to latch an external control device. These decoded output signals are TTL level. If music is not what you want, you can use the circuit to provide 16 preadjusted tones for use in testing or remote-control applications (see "Computer Bits," August 1977). To obtain all 16 tones, you must add diodes and potentiometers to the circuit as shown for the other outputs. ◇

You meet the nicest people on the upper 17.

The most serious CB'ers were the first to move from 23 to 40 channels. And the upper 17 are still their uncrowded province.

President Electronics never made a CB with fewer than 40 channels. We set out fresh to meet the FCC's tough new standards with new electronics and new ideas.

That's why every President has one of the most sophisticated compression circuits in CB—to assure consistent 100% modulation.

And why every President has power output circuits that are vastly improved over many old 23-channel designs.

So when you move up, move up to President.

And if you want to move all the way up, move up to the Madison—the most base station your money can buy.

Madison not only gives you 40 AM channels . . . it also gives you 40 upper and 40 lower sideband channels. And it gives you the extra range and performance you get only from superb SSB, with 12 watts of peak envelope power.

And it gives you all the controls you need for complete command of everything that comes out of or goes into the radio . . . And a digital clock with alarm to remind you of scheduled QSO's . . .

And a separate speaker for improved sound and improved convenience . . . And more.

We did, however, leave off the automatic ice maker.

Today, owning a 23-channel CB is like owning a mono record player—great nostalgia, but out of touch.

So get in touch with the upper 17.

There's room.

PRESIDENT

Engineered to be the very best.

CIRCLE NO. 50 ON FREE INFORMATION CARD

President Electronics, Inc.
16691 Hale Avenue · Irvine, CA 92714 · (714) 556-7355
In Canada: Lectron Radio Sales Ltd., Ontario

CB Today & Where It's Going

• An introduction to a special 16-page report.

EXAMINING a CB radio mobile handbook published in 1962 underscores how far this low-cost, two-way radio communications system has traveled . . . and how much the same it is today. One striking sentence published fully 16 years ago in this book (four years after the CB band was moved to 27 MHz from higher frequencies authorized in 1947) was: ". . . the Commission never envisioned the CB'er who owns one set and talks to other licensees!" That was the reason given then for the FCC's initiation of the famous five-minute conversation limit rule.

The Citizens Band Today? It's a more meaningful form of short-distance radio communications than ever for the general public. There are said to be some 25-million CB transceivers spread around the U.S., creating a viable local network for emergency communications, informational assistance for motorists, and social conversations. And it's got a new name—the Citizens Band Radio Service, which is a subdesignation in the Personal Radio Service.

The new 17 CB channels added last year will most certainly be used more and more since the FCC banned sales of new or used 23-channel transceivers as of January 1, 1978 (excepting hand-held types, which may be marketed without 40-channel capability until August 1, 1978). Although there was an increase of 74 percent in channel availability that now stretches from 26.96 to 27.41 MHz, channel 9 remains the emergency calling channel.

A host of modified rules and decisions over the past year or two has changed the complexion of CB for the better. For example, one can get on the air legally without waiting for a station license by using Form 555-B packed with each new CB transceiver; subpart D of the FCC's Part 95 Rules and Regulations has been broken out as a separate publication to be packaged with new transceivers; there is no charge for a CB license; new 40-channel transceivers must meet more stringent technical requirements; and, most recently, proceedings on creation of a Class E (224-225 MHz) CB band have been terminated.

Other decisions attest to CB radio's growing importance in our lives. The U.S. Coast Guard, for instance, announced it would install CB gear at Coast Guard Search and Rescue stations throughout the U.S. in time for the 1978 recreational boating season. Federal funds are now issued to states with organized CB programs, with the National Highway Traffic Safety Administration stating that the "Citizens Band offers the only existing method convenient to the public by which the motorist can enter the emergency response system from his/her vehicle." As a consequence, it will be progressively easier to reach a highway patrolman for aid as time goes on. Right now, in fact, CB radio public safety programs have been established by 94 percent of the nation's state police organization's, with CB radios already installed in 48 percent of the police vehicles in 34 states. Supporting the federally funded NEAR (National Emergency Aid Radio) program, REACT, the largest voluntary CB emergency service organization, was recently awarded a contract to develop a CB channel-9 monitor training program for public safety officers and volunteers.

The foregoing does not mean that CB radio is cleansed of all its problems. There are still violators of FCC rules, the most important being: (1) Out-of-band communications; (2) Overpowered transmitters; (3) Indecent language; (4) Communication over 150 miles away (skip); and (5) Failure to identity by call-sign. Furthermore, CB-caused TV and audio interference is still a challenge.

The CB industry itself is in the process of stabilizing. The problems it had appear to have been precipitated by the FCC's announcement in July 1976 that 40-channel CB transceivers could be sold as of January 1977. While people waited for the introduction of new 40-channel models, 23-channel inventories mounted. The result was a drastic reduction in prices of 23-channel models that proved irresistible to the public, which, in turn, caused discounted prices on 40-channel models. The upshot was that most CB manufacturers lost money during this period, while the public was getting the best values in memory. With a more mature market, you can anticipate that selling prices will edge upward.

Where Is CB Going? In the short term, more and more single-sideband and increasingly sophisticated AM CB transceivers are likely to be purchased. The reasons are multifold. For one, advanced technology presents prospective users with a better rig, both in raw performance and in convenience features: electronic digital readouts, calculator-type control keypads, memory, automatic channel scan, separate VFO for receive-only with a second digital channel display, improved front-end overload circuitry, superior selectivity, precision SSB tuning, remotely controlled mobiles, and so on. Secondly, many millions of CB'ers are ripe for upgrading their present equipment, having tasted the benefits of two-way radio communication. (It's also expected that many CB'ers in this group will turn to amateur radio, expanding their communication horizons while maintaining CB rigs for emergencies.)

Technological developments do not necessarily mean exhorbitant cost, either. For example, National Semiconductor's single-chip frequency synthe-

sizer/programmer for CB radio use is claimed to reduce component count by as much as 60–70 percent. Features include two-speed-slew, up/down channel selection capability, busy or clear channel scan, channel memory, LED blanking control in the event an auto clock circuit is added, channel 9 selectability, and more. ECL and I^2L transistors are fabricated on the same chip.

You can expect standardization of selective calling signals somewhere down the road for CB radio. A technical committee of the EIA is already working on this for add-on to existing models and incorporation into future ones. There will be ongoing efforts to reduce interference on TV sets, too. CB radio manufacturers have already suggested that CB harmonic emissions be limited to −75 dB as compared to the present −60 dB. Further, FCC Commissioner Lee told TV manufacturers to get ready for an FCC drive to upgrade interference capabilities of TV receivers.

With few FCC enforcement personnel, it's expected that self-regulation efforts will be pursued to minimize communication violations by CB'ers. The FCC may well utilize the services of volunteers in a program of first-level screening and offender identification, a proposal already being considered. Also, a new series of radio Public Service Announcements has been prepared to remind CB'ers on proper usage of personal communications equipment. The on-again/off-again ATIS (automatic transmitting identification signal) proposals appear to be shelved for now.

There are many spectrum alternatives being analyzed to cover future growth of personal radio services. None seem imminent at this time, but somewhere down the road such a decision would have to be made to avoid channel congestion. Right now, though, the new 17 channels are essentially clear and clean, providing users with farther-reaching signals than they got with the older channels.

At some distant time, one may also expect a CB rig to perform as a true mobile telephone. Interestingly, International Resource Development Inc., a market research company, does indeed project a future merger between CB and the telephone, as well as skyrocketing growth in personal radio use after a short pause. Among other prospects is the use of repeaters in sparsely populated areas to extend a CB radio's range.

It would seem appropriate, too, in future planning to carve out SSB-only channels. To take full advantage of the spectrum-saving function of SSB, even at present, would require tighter technical specifications so that both lower (most popular) and upper sidebands on one channel can be used optimally.

Clearly, CB radio is no longer a fad. The over-riding reason for purchasing a CB rig, in fact, is to handle distress situations, as borne out by a recent study by the International Trade Commission. This isn't surprising since more than 40 million emergency and assistance requests are reported to be handled annually by the CB Radio Service. Equally impressive, the former Superintendent of the Missouri State Highway Patrol advised that lapsed time between occurrence and notification of accidents was almost halved when reported by CB radio as compared to conventional means.

See "Editorial" for report on CB at the 1978 Consumer Electronics Show. ◇

Buyers Guide to Super Mobile Transceivers

Features and specifications of top-of-the-line models for comparison before buying.

BY IVAN BERGER *Senior Editor*

A NEW breed of super mobile CB transceivers has been introduced to the marketplace this year. They feature higher performance capabilities than ever before, lower interference emission and more convenience features. Each CB manufacturer's best AM/SSB and AM model is listed in the buyer's guide on the following pages.

Specifications. All of the top-of-the-line SSB and AM mobiles listed in our chart cover 40 channels and virtually all manufacturers claim 100% modulation and the maximum power that the law allows: 4 watts on AM, 12 watts PEP on SSB. All have squelch, on-off-volume knobs and external speaker jacks; nearly all (except most of the control-in-the-mike remote-mount models) have S/r-f metering, and virtually all have digital channel displays. Because of these similarities, you won't find those features in the table. Sensitivity figures for about 90% of these rigs are 0.5 μV for 10 dB (S+N)/N on AM and 0.25 μV for SSB, and most makers rate audio power output at the 10%-distortion point. Exceptions to these specifications are noted under "Remarks."

Two specifications measure a CB rig's ability to reject unwanted signals. *Adjacent Channel Rejection*, as the name implies, tells how well the rig can reject signals of channels on either side of the tuned-in one. It's measured at ±10 kHz, of course. The higher this number, the better. *Selectivity* here is the bandwidth or i-f "window" at which the receiver's response falls by 6 dB. The narrower this frequency range, the greater the immunity to "splatter" from overmodulating stations on adjacent channels. If it's too narrow, however, voices will sound unnatural and that's not good either.

Image Rejection measures the receiver's ability to attenuate an undesired image signal generated by the converter stage. *Spurious Response Rejection* measures the transceiver's resistance to spurious signals created by the interaction within the tuner front end of strong external signals. The higher both figures, the better.

Most mobile sets will operate on both negative-ground cars (the most common type) and positive-ground ones. Where the manufacturers supplied the information, we show the permissible ground polarities as either "±" or "−".

About This Month's Cover

Although the CB mobile transceiver illustrated on our front cover doesn't exist, most of its features are available in one or another of the new CB models available today. With more and more CB manufacturers limiting much of their development and manufacturing efforts to "high-end" models, it would not surprise us to find all the features in our imaginary model combined on one chassis at some future time.

Like virtually all of today's top CB transceivers, our dream model has electronic tuning and LED digital channel readout. This permitted us to include several tuning options that are currently available (though not all on the same model), plus a few practical approaches we haven't seen yet.

The UP and DOWN buttons (duplicated on the mike) let you scan manually to any desired channel, while the keyboard lets you jump to any channel directly. If you're trying to hold a conversation, but find the channel is crowded, press our dream rig's SCAN VACANT rocker switch. (It's one of the controls in the group labelled SCAN on our drawing—detailed switch designations aren't shown.) This will find and display the nearest vacant channel number. After you tell the party with whom you were modulating what channel is vacant, pressing the switch the other way, to TUNE VACANT will move you directly to that channel. If you're looking for a conversation, the SCAN ACTIVE button will find it for you. SCAN MEMORY looks for activity, too, but only among the stations you've programmed into either of the two memories: M1 for the channels you use within your normal driving area, or M2 for channels you use when driving elsewhere.

SELECTIVE CALL facilities like our dream rig's should be available soon: one button, under the numerical keypad, programs in the selective-call number to be transmitted; the button beneath it is used to transmit that calling code. Two other keys work with the number pad to set your own call number and the channel or channels you expect to be called on. After that, any properly coded calls on any of those channels automatically take priority over the one you're using.

ON-OFF and VOLUME controls are separate, so you needn't reset the volume control whenever you turn the rig on. The VOLUME, SQUELCH and AM/SSB selector settings can be determined by touch, for safety, and the two SSB controls—the sideband selector and the clarifier—are grouped together. SQUELCH control setting can be determined by touch, as can that of the AM/SSB selector just below it. The CLARIFIER control is to the AM/SSB selector's left.

Grouped under QUALITY are: an ANL switch; a two-position NOISE BLANKER (for a choice of blanking time), a WHISTLE FILTER and a BROAD/NARROW i-f selector. To the left of the foregoing are RF GAIN and MIKE GAIN knobs; to the right is a TONE control. Still further right is the TALK TIMER It squawks when you've exceeded the statutory 5-minute limit on talking time, and its surround ring blinks as you approach that limit.

The optional clock module counts down from 5 minutes whenever you press the talk switch on the mike. It also tells you the time of day, between transmissions; and has an elapsed-time mode, too. A separate HOURS reset button simplifies resetting when you drive from one time zone to another. An interlock button prevents accidental resets.

The meters, of course, are as large as practical. In addition to the switch-selectable SWR metering, there's an alarm LED to warn you when the SWR approaches limits that could damage your transmitter—if the antenna is damaged, for example.

If our dream rig looks unusual, it's because we paid more attention to human engineering than to styling. Hence, the wide variety of controls' shapes and sizes (for easy touch identification) and the angled keypad (a more natural angle for the driver's hand with center buttons recognizable by touch.

Maximum current drawn by the rig is shown in the chart, too.

Listed Features. In addition to the basic features found on virtually all CB transceivers, there are several fairly common extras noted here. (For rarer ones, see "Remarks".) The *Automatic Noise Limiter* (ANL) circuit clips noise pulses that ride in on the received signal, but not noise which was part of the signal as it was transmitted. The *Noise Blanker* circuit momentarily squelches noise within the signal. It is more effective than ANL on AM, and quite a bit more effective on SSB. Where manufacturers have specified that their ANL or noise blanker controls are switchable, we've marked them with an "S". Switching out the ANL will usually increase volume and decrease distortion slightly. Switching out the noise blanker should have no audible effect (save for an increase in noise.) All too often, however, this will increase the receiver's apparent sensitivity, rather as if the squelch had been turned down a bit.

Some rigs have *R-F Gain* controls to prevent strong-signal overload; an "S" here means a two-position switch (sometimes labelled LOCAL/DISTANT) instead of a variable knob. *Mike Gain* controls assure maximum legal modulation even if you're speaking softly—on most sets, automatic level controls perform this function). Next comes a *Tone* control, followed by *Up/Down Tuning* (as in our dream rig).

Remote-mount means that the bulk of the transceiver circuitry is in a featureless, concealable box, with most or all controls on the microphone. (Some sets have a few controls or indicators on a separate speaker box.) *PA* switches are found on virtually all CB rigs; where the makers specified a *Separate PA Speaker Output*, that column is checked. A *LED Dimmer* brightens the channel numbers for daytime viewing and dims them at night to prevent glare.

Many sets today have various *Priority Channels*, allowing you to switch instantly to channel 9 for emergencies, to channel 19 for traffic advisories, or perhaps to some other channel or channels of your choice. (These are given only in the table for AM rigs.) Some will also scan the priority channels ("S" in our chart). Switching to one when there's activity. Others will, like our dream rig, scan for active channels ("Sa") or for vacant ones ("Sv"). Since this feature is rare on SSB rigs, we've used *Clarifier Range* for that column in the SSB table—priority and scan features, if any are also under "Remarks."

Indicators for *Percent Modulation* and SWR may be either meters ("M") or LED's ("L"). Modulation meters differ from the usual "RF" meters primarily in being calibrated in percentages, rather than in arbitrary units. If LED's are used for SWR, they usually serve only to warn when SWR has become high enough to possibly damage the transmitter. ◇

SUPER SSB MOBILE TRANSCEIVERS

Manufacturer and Model	Price	Automatic Noise Limiter	Noise Blanker	R-F Gain Control	Microphone Gain Control	Tone Control	Up/Down Tuning	Remote-Mount; Controls on Mike	Separate PA Speaker Output	LED Dimmer	Clarifier Range (kHz)	SSB	Indicators: Percent Modulation	Indicators: SWR	Adjacent-Channel Rejection (dB)	Selectivity: Bandwidth for 6 dB (kHz)	Image Rejection (dB)	Spurious Response Rejection (dB)	Audio output (watts)	Maximum current consumption (A)	Ground Polarity	Approximate Dimensions (inches)	Remarks
Boman CB-950	$390		S	✓						✓	±0.6		L	M	50				3.5^u				
Browning Baron	$300	S	S	✓						✓	±1.5			M	50				6^u		±	2-3/8 x 7 x 12	AM r-f output 3.5W.
Cobra 132XLR	$330	S	S	✓	✓				✓	✓	±1.0	L	M	M	50	3.8 2.2^s	50		3.5^u		±	2-3/8 x 7-1/2 x 11	
Colt 480	$200	S	S	S											50		50		5	1.5	±	2-1/2 x 7-1/2 x 10	
Convoy CON-160	$385		S	✓					✓	✓											±	2-1/2 x 8 x 10-5/8	PA indicator light and level metering.
Cornell-Dubilier Mk. 26	$375		S	✓							±1.5			M	50^a 80^s	±2				2.2	±	2-3/8 x 7-1/8 x 10-7/8	
Courier Gladiator Model PLL-40	$400		S	✓					✓		±0.8			M	80	±2.5 $±2.1^s$	50	-60	5	2.2	±	3 x 10-5/8 x 12-3/8	SSB Sens. 0.15μV.
CPI CP-400	$199		✓								±1.5				60		70	-70	2*	2.5		2-1/4 x 9 x 11-3/4	Distortion 3%.
Craig L131	$360	S	S	S						✓	±0.6		L	M	60		60		3.5	2.4	±	2-1/4 x 8-1/2 x 10-1/4	SSB Sens. 0.18μV; Slide-out mount.
General Electric 3-5825	$330	S	S	✓		S •			✓		±0.8		L	L	50		35	-40	3.5	1.2	±	2-1/2 x 7-1/2 x 10-1/2	
Hy-Gain 2705	$370	✓	S	✓							±0.6				50	±3 $±1.2^s$	35	-40	3		±	2-3/4 x 8-1/2 x 11-1/2	AM Sens. 1μV.
Johnson Viking 4740	$360	.	S	✓						✓		L			60	±2	40	-50	2^u		±	2-3/8 x 7-1/2 x 10-3/4	SSB Sens. 0.3μV.
Lafayette LMS40	$230	S	S	.					✓		±1.5			L	60		60	-60	3^u	3	±	2-3/8 x 7-1/2 x 11	Sens. 0.7μV(AM), 0.35μV(SSB).
Midland 79-892	$340		S	✓		✓															±		
Motorola CM550	$320	✓	S	✓	✓						±1.4	U&L	L	M	60	4.1	70	-60	3	2.3	–	2.6 x 7.1 x 9.4	Mic gain doubles as PA volume control.
Pace 8092A	$270	S	S	✓					✓		±1.4	U&L		L	60		70	-60	3^u		±	2-1/2 x 8 x 10-1/4	Digital display doubles as clock.
Palomar SSB-2900	$300	S	S	S							±0.8		M		50^a 60^s		50^a 80^s	-65	3*	1.5	±	2-1/2 x 7-1/2 x 10	AM Sens. 0.7μV; Dist. 5%
Panasonic RJ-3700	$300	S	S	✓									L		55 60	5	45	-45	2	3	±	2-1/2 x 8-3/4 x 12-3/8	Quick-release mount.
President "Adams"	$370	S	S	✓	✓	✓			✓	✓	±1.3		M	M	70	±2.1	70	-60	3	3	±	2-1/2 x 9 x 10-5/8	AM Sens. 0.75μV; scans priority channels 9,19, plus one programmable.
Realistic TRC-449	$300	S	S	✓					✓	✓	±1.3		L		65		80		4		±	2 x 8 x 10-1/2	
Royce SSB 639	$200	S	S	✓	✓				✓	✓	±1.5		M	M		5 1.8^s			3.5^u		±	2-1/8 x 7-3/4 x 8	SSB Sens. 0.2μV; Ch-9 priority.
SBE Sidebander V	$420	S	S								±1.5				70^a 75^s		60	-60	4				Keyboard control; memory scan; Ch-9 priority; Sv.
Sharp CB-5470	$250		S	✓					✓		±0.7				50		60	-50	3.5	1.9	±	2-3/4 x 7-7/8 x 9-5/8	SSB Sens. 0.15μV; flashing Ch-9 indicator.
Teaberry 4012 Ranger	$330		S	✓					✓		±1.5				70	±2	40		3		±	2-3/8 x 7-7/8 x 9-7/8	SSB Sens. 0.3μV.
Tram D-62	$350	S	S	✓	✓				✓		±1.5		L	L	70	3.5 $±1.3^s$	60		4	2.5	±	2-3/8 x 7 x 10-3/4	Quick-release mount.
TRS Challenger 850	$300	S	S	✓								U&L	L		50				4^u	2.5		2-3/8 x 7-3/4 x 10	Sens. 0.7μV (AM), 0.3μV (SSB); SSB select. -50 dB @ ±25 kHz.

See next page for symbols and abbreviations.

SUPER AM MOBILE TRANSCEIVERS

Manufacturer and Model	Price	Automatic Noise Limiter	Noise Blanker	R-F Gain Control	Microphone Gain Control	Tone Control	Up/Down Tuning	Remote Mouse; Controls on Mike	Separate PA Speaker Output	LED Dimmer	Priority Channel	Indicators: Percent Modulation	Indicators: SWR	Adjacent-Channel Rejection (-dB)	Selectivity: Bandwidth for 6 dB (kHz)	Image Rejection (-dB)	Spurious Response Rejection (dB)	Audio Output (watts)	Maximum Current Consumption (A)	Ground Polarity	Approximate Dimensions (inches)	Remarks
Aircommand CB-640	$230	S	S	✓		✓					9+1	M	M	60		50		6	1.5	±	2-1/2 x 7-5/8 x 9-1/8	Ch.-9 alarm; Aux. input plays car stereo over PA speaker.
Alaron PD-7000	$150	✓			✓		✓	✓	✓			L		70		70	-65	3*	1.5	-	2-3/8 x 4 x 7	Sens. 0.4µV; Dist. 5%
Arthur Fulmer 15-4035	$190	✓		✓											6			3^u		±	2 x 6-1/4 x 7-3/4	Sens. 0.7µV
Audiovox MCB-5000	$220						✓	✓														Standby.
Automatic Radio BBM-3444	$205	S		✓	✓			✓				L		50				4.5	2	-	1-3/8 x 7 x 7-7/8	Sens. 1.0µV;Standby.
Beltek Enduro 40A	$160								✓			L			6	60	-40	4*		-	2-1/2 x 5-7/8 x 9-1/8	For motorcycles; has intercom capability; 3.5W r-f; Sens. 0.7µV; Dist. 5%; Boom mike.
Boman CBM-6000	$330				✓		✓	✓														R-f output 3.5W
Bristol BCB-227	$160	S										L		50	±3	60	-50	3^u		±	2-3/8 x 6-1/2 x 7-3/4	Sens. 0.7µV.
Clarion RJC-003	$200						✓	✓								60				-		Standby.
Cobra 32XLRA	$200	S	S	✓	✓				✓	✓	1,S				±4	40		3^u		±	2-3/8 x 7-1/2 x 9-3/8	Ch.-9 indicator.
Colt SX 33	$150	✓					✓	✓						50	±4	50		5	1.5	±	2-1/4 x 5-1/2 x 6-3/4	
Convoy CON-450	$220	S	S	✓		✓			✓					60		40	-40	2	1.6	-	1-7/8 x 6-1/2 x 7-1/4	Sens. 2µV.
Cornell-Dubilier Mk.16	$230		✓	✓									M	50	±2				1.3	±	2-3/8 x 7-1/8 x 9-1/8	
Cornell-Dubilier Mk.17	$230							✓			5S,Sv,Sa			50				3	1.2	-	1-1/4 x 7 x 7	Sens. 1µV.
Courier Blazer 400	$100	S		✓					✓	✓				50	±3	50	-60	3	1.3	±	2 x 5-7/8 x 8-1/4	
Craig L102	$160	S	S	✓					✓	✓		L	M	60	±3	60		4	2	±	2-1/4 x 8-3/4 x 10	Slide-out mount.
Fanon Fanfare 184DF	$100	S		✓					✓	✓				50	±3	50	-60	3	1.3	±	2 x 5-7/8 x 8-1/4	
Fujitsu Ten CAS231	$190						✓	✓						60		45	-50	2.5^u		-		Sens. 0.7µV; standby opt
General Electric 3-5821	$240	S	^{a}S	✓		✓			✓		1S	L		50		40	-40	2.2	1.2	±	2-3/8 x 7-1/2 x 9-3/4	Sens. 1µV; priority channel with signal and separate squelch; CH-9 priority crystal, others optional.
Handic 199	$190	S					✓	✓						60				3.5	1.6		2 x 6 x 8	Selective-call option, $80.
Hy-Gain 2716	$250		S				✓	✓	✓		9+1			40	±3	35	-40	3			2-1/2 x 8 x 8-3/4	LED digital clock, "S" and r-f display.
Johnson 4360	$230						✓	✓		✓					±3		-42	3^u		-	2-1/4 x 6-1/4 x 9-3/8 4-3/8 x 5-1/4 x 5-3/4	Telephone-type handset; readout in speaker box.
Kraco 4060	$200							✓	✓		9			100		100	-50	2.5	2	±		

Symbols and abbreviations: ^{a}AM; L=LED indicator; M=meter; S=switched; ^{s}SSB; Sa=scan for active channel; Sv= scan for vacant channel; S=scan(in Priority-Channel column); ^{u}Distortion unspecified; U&L=Upper & Lower sideband indicator lights; *See "Remarks" for distortion level;

SUPER AM MOBILE TRANSCEIVERS *Continued*

Manufacturer and Model	Price	Automatic Noise Limiter	Noise Blanker	R-F Gain Control	Microphone Gain Control	Tone Control	Up/Down Tuning	Remote-Mount; Controls on Mike	Separate PA Speaker Output	LED Dimmer	Priority Channel	Indicators: Percent Modulation	Indicators: SWR	Adjacent-Channel Rejection (-dB)	Selectivity: Bandwidth for 6 dB (kHz)	Image Rejection (-dB)	Spurious Response Rejection (dB)	Audio Output (watts)	Maximum Current Consumption (A)	Ground Polarity	Approximate Dimensions (inches)	Remarks
Kris XL-50	$260		S	✓	✓	✓				✓		M		60	5	45	-55	3	2.5		3 x 8-7/8 x 9-1/2	3 separate meters
Lafayette LM-300	$150	✓	S	✓					✓		1	L/M	M	60		60	-55	3	1.6	±		Sens. 1μV; Priority-channel alert.
Lake 750	$120		S										L	50		70		3^u		±		
Midland 77-861	$208	✓																		±	3-1/4 x 4-5/8 x 7-5/8	Combination mobile/portable model with batt., batt. meter, telescoping antenna, carry case; 3½ lb.; Sens 0.7μV; r-f output in portable mode switchable 3.1/1.5 w.
Motorola T4009	$190	✓	S							✓	9,S		M	55		10	-50	2.5*		-	2.5 x 7.3 x 9.4	Priority channel with defeat (Ch-9 crystal supplied, others optional) and separate squelch Dist. 5%.
Pace 8040	$150	S	S	✓	✓	✓	✓			✓	S		L	55				4^u		±	3-1/2 x 6-3/4 x 7	Keyboard entry; channel selector on mike.
Palomar 4100	$240	S	S	✓					✓					60	±3	60				±	2-1/4 x 7-1/4 x 7-1/2	
Panasonic RJ-3450	$230	S	S				✓	✓			9,Sa, Sv			55	5	45	-45	4*	2		2-7/8 x 7-5/8 x 8-3/4	Audio output through built-in speaker, 0.2W.
Pearce-Simpson Lion 40	$250	S	S	✓		✓							M	50	5	90		3			2-1/4 x 7 x 8-1/2	Sens. 0.7μV.
President "Teddy R"	$180	✓	S	✓	✓				✓	✓		M	M	60			-55		1.5	±	2-3/4 x 7-3/4 x 9-5/8	Switchable high filter.
Ray Jefferson CB-845	$200	✓	✓	✓									M					3^u			2-1/2 x 7 x 8-1/2	
Realistic TRC-456	$200	S	S	✓					✓			L		60	±3		-65	3.5		±	5 x 7 x 8-1/2	
Regency CB-501	$150	S								✓				55		50		4		±		Quick-release connectors
Royce CB613	$190	S		✓		✓	✓		✓		9		L/M	60	5		-50	2.5		±	2-1/8 x 7-3/8 x 7-5/8	Sens. 1μV; Quick-release mount.
SBE Key-Com 1000	$260	S	S	✓			✓		✓	✓	9+10, Sa			70		60	-60	4	1.9	±	2-1/8 x 5-7/8 x 8-3/4	Keyboard entry; 10-channel memory with scan; auto transfer to programmed priority channels and Ch. 9.
M.H. Scott DAK Mk. V	$160	S	S	✓					✓	✓		L								±	2-1/4 x 7-3/4 x 9	
Sharp CB4670	$180	S						✓	✓		9			50		60	-50	3.5	1.4	±	2-1/2 x 6-3/4 x 7-1/4	S/r-f meter in speaker cabinet.
SparkOmatic CB-4100	$170	✓		✓			✓	✓			S			50		55	-60	3		±	1-3/8 x 5-3/8 x 6-1/2	
Teaberry 4004 "T" Bear	$200		S	✓		✓			✓	✓		L		70	±3	50		3		±	2-1/4 x 7-1/2 x 10-1/4	Sens. 1μV.
Tram D-42	$160	S	S	✓	✓	✓			✓			L	L/M	80	±3	60		4	1.8	±	2-3/8 x 7 x 9-1/4	Quick-release mount.
TRS Challenger 730	$230	S	S	✓			✓	✓				L		80				4^u	2		2 x 7 x 8-1/2	Sens. 0.7μV; PA gain control.

Symbols and abbreviations: ^{a}AM; L=LED indicator; M=meter; S=switched; ^{s}SSB; Sa=scan for active channel; Sv= scan for vacant channel; S=scan(in Priority-Channel column); ^{u}Distortion unspecified; U&L=Upper & Lower sideband indicator lights; *See "Remarks" for distortion level;

Choosing a Mobile CB Antenna

● How to Select and Install Mobile CB Antennas.

BY JOHN J. McVEIGH, Asst. Technical Editor

WHERE range is concerned, the only factor truly under the control of the CB'er is the antenna—its type and where it is installed.

Antenna Basics. All antennas employed in two-way communications perform two functions: (1) accept r-f power from the transmitter and radiate it into space, and (2) capture a portion of the radio signals passing by and present them as small voltages to be processed by the receiver. For maximum range, antennas should perform these two functions as efficiently as possible.

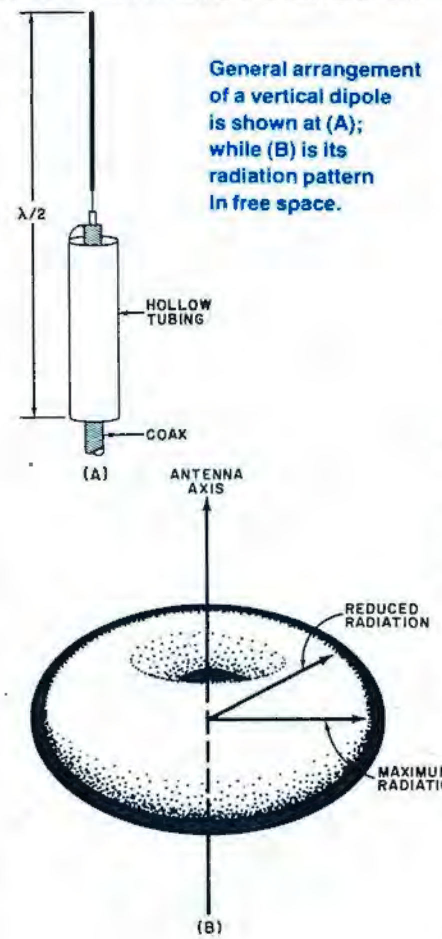
The elementary antenna from which most others are derived is the half-wave dipole. It is composed of two quarter-wavelength conductors and is fed in the center by a transmission line. The dipole can be installed so that its conductors lie in the horizontal or vertical plane.

Although a horizontal dipole possesses some qualities desirable in CB mobile communications, such as its greater ability to reject ignition noise, it's size makes it impracticable. Only a small fraction of all the vehicles on the road could accommodate a dipole 17.2' (5.2 m) long! The vertical dipole, shown in Fig. 1A, is a more realistic alternative.

One of the characteristics of a dipole is *directivity*. That is, the antenna works better in some directions than others. If it is mounted in free space, the dipole's radiation pattern is as shown in Fig. 1B. It is most effective at right angles to itself, and least effective off its ends.

To an observer in the same plane as the antenna (standing upright and looking directly at it), the antenna appears to be omnidirectional. For a given *radiation angle* (the angle at which the signal takes off from the antenna), the horizontal radiation pattern of the vertical dipole is circular—the antenna receives signals from or radiates them to all points of the compass with equal facility. In other words, it is *omnidirectional*. Keep in mind, however, the three-dimensional aspect of the pattern. The vertical dipole is most effective when signals strike or leave it at right angles.

The vertical dipole's omnidirectionality in the horizontal plane means that no loss in signal will occur if the mobile you're talking with up ahead makes a left or right turn or follows a curve in the road. If horizontal dipoles were employed, each would end up in the null of the other's radiation pattern. It is true that the described patterns are those of antennas in free space, and that proximity to the earth and metallic objects distort them. But even real-life horizontal dipoles display some directionality.



General arrangement of a vertical dipole is shown at (A); while (B) is its radiation pattern in free space.

Another beneficial quality of the vertical dipole is its low angle of radiation, especially when mounted near ground. If it is mounted at right angles to the earth's surface, it is most sensitive to (and best radiates) ground-wave signals—those travelling parallel to the surface of the earth. In line-of-sight communications, the ground wave predominates. The vertical dipole will therefore reject skip signals to some extent, and will be most efficient for ground-wave mobile-to-mobile and mobile-to-base communications.

There are, however, some disadvantages associated with vertical antennas. Because they are omnidirectional in the horizontal plane, they will bring in stations from all points of the compass—both wanted and unwanted. On transmit, signal power will be radiated in all directions, not only toward the stations with whom you are communicating, but also areas where there are no stations.

The major disadvantage associated with the vertical half-wave dipole is its *size*—about 17.2 feet (5.2 m) at CB frequencies. A mobile antenna of that size would not only be physically unwieldy, but would also be highly vulnerable to damage from shocks inflicted by highway overpasses, overhanging tree branches, etc. Full-size, half-wave "coaxial" vertical antennas are commonly employed at base stations and on CB-equipped pleasure craft, but their dimensions rule out their use for mobiles.

Ground Planes provide a solution to the vertical dipole's height problem. If a quarter-wave vertical conductor is placed over a large horizontal conductive sheet, a "phantom" quarter-wave element is generated. The conductive sheet, called a *ground plane*, acts like a mirror and supplies the antenna element necessary to form a half-wave radiator. Ideally, the ground plane should be a perfectly conducting disc with a radius large as compared to the wavelength at the operating frequency.

Practicality imposes several limits on the structure and composition of the ground plane. Even at base stations, a metallic disc with a radius of only a quarter wavelength (about 8.6 feet or 2.6 m)

would be unwieldy. Four radial wires, each one-quarter wavelength, provide a ground plane at many CB base installations. The mirror image produced by the ground plane permits the use of an antenna only a quarter wavelength high.

In mobile applications, four radial wires are impractical. Instead, the metallic vehicle body is used. Although a far from ideal ground plane, the car body will work—to an extent—and is eminently practical. However, the vehicle body must be metallic.

Loading. Even though the use of a ground plane reduces the height of a vertical antenna by one half, a quarter-wave whip at CB frequencies (104" or 2.6 m) is rather large. Some CB'ers install such antennas on their vehicles, but for practical reasons they can mount them only on a bumper. (That is not a very good mounting location, as will be developed later.)

When positioned over a ground plane, a vertical whip will *resonate* at the frequency for which its length is one-quarter wavelength. That is, its feedpoint impedance will be purely resistive. If the whip is too short to be a quarter wavelength at the operating frequency, its feedpoint impedance will contain some capacitive reactance. CB transceivers, however, operate optimally when looking into purely resistive 50-ohm loads. By adding the right amount of inductive reactance—supplied by a loading coil—to precisely cancel out the antenna's capacitive reactance, only the resistive component is left. The antenna's *electrical length* is such that it resonates at the operating frequency.

A loading coil, in effect, supplies the missing physical length required for resonance. For a given operating frequency, more and more inductance is required for resonance as the antenna is physically shortened. Some CB mobile antennas are only 18" (45.7 cm) long—quite a reduction from 104" (2.6 m)! They require a lot of loading inductance. Most mobile whips designed for roof or trunk mounting use less loading and longer whips, keeping element length in the physically manageable 48-to-54-inch (1.2-to-1.37-meter) range.

Loading is a compromise solution to the antenna height problem, not a perfect one. Two of its principal drawbacks are a reduction in antenna efficiency and a narrowing of bandwidth. The degradation of antenna efficiency is caused by the resistance of the wire which forms the coil. Some of the transceiver's r-f output will be wasted heating the coil, rather than being radiated by the antenna. For a given wire composition, more inductance means more turns of wire, hence more resistance and increased power loss. A mini-whip, requiring a large loading coil, will therefore be less efficient than a longer antenna with a smaller loading coil. Manufacturers try to keep this power loss low by using low-resistance wire in their loading coils.

Reduced bandwidth is a natural consequence of antenna loading because the introduction of inductive reactance raises the "Q" of the antenna. As the operating frequency moves away from that of resonance, the feedpoint impedance of the antenna changes, producing a mismatch between the antenna and feed line. Standing waves then appear on the line and the transceiver sees a reactive load.

Some impedance mismatch is inevitable and is tolerable up to a point. A mismatch of impedances by a factor of two (by definition, a standing wave ratio or SWR of 2:1) is acceptable, but greater mismatches can cause problems to the transmitter and a loss of antenna efficiency. Just how much the antenna's impedance changes with frequency determines how far above or below resonance it can be used before the mismatch becomes intolerable.

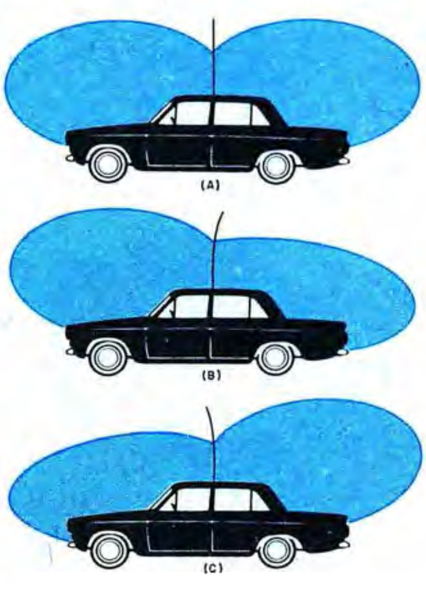


Fig. 2. Radiation pattern of vertical whip (A) is distorted when antenna sways backward (B) or forward (C).

A full-size quarter-wave whip working against a good ground plane will easily cover the 40 CB channels while maintaining an acceptable match. However, a very short miniwhip will have difficulty presenting a matched impedance over even the original 23 channels. Most mid-size whips can be used on 40 channels if tuned for the best impedance match at the center of the band.

Apart from physical convenience, there are two compelling reasons for using inductively loaded, less-than-full size vertical whips in mobile CB communications. One deals with ground-plane effects, and will be considered later. The other results from the physical behavior of a large whip on a moving car. With the vehicle stationary and the antenna upright, a radiation pattern like that shown in Fig. 2A is produced.

If the whip is long and springy, onrushing air will deflect it once the car is moving, resulting in the radiation pattern shown in Fig. 2B. This pattern indicates that some of the radiated r-f will be sent up into the blue—at the expense of the ground wave, the real medium of communications! If the car hits a bump or sharply decelerates, the whip can pitch forward, again producing an undesirable radiation pattern (Fig. 2C). Of course, distortions in the pattern will also occur if the whip sways from side to side.

As the whip bounces around, the signal received by another CB'er will flutter in strength. The same effect will be experienced on receive by the operator using the tall whip. Also, the load impedance as seen by his transmitter output stage and the SWR on the line will vary. These undesirable effects can be minimized by either shortening the antenna and inductively loading it or constructing it so that it is rigid.

Loading, within limits, is a good solution. Making the antenna rigid will cure the problem, but makes the antenna susceptible to damage from overhanging objects. Those manufacturers who produce stainless steel antennas use special alloys and element tapers to enhance the antenna's ability to remain upright while maintaining the flexibility necessary for absorbing shocks. Loaded fiberglass whips are more rigid than stainless steel and thus have less flutter.

Fiberglass antennas are also less susceptible to the buildup and discharge of static electricity, which can produce a hissing noise in the receiver. (Stainless steel whips usually have tip-mounted balls to inhibit static discharge.) The principal drawback to the use of a rigid

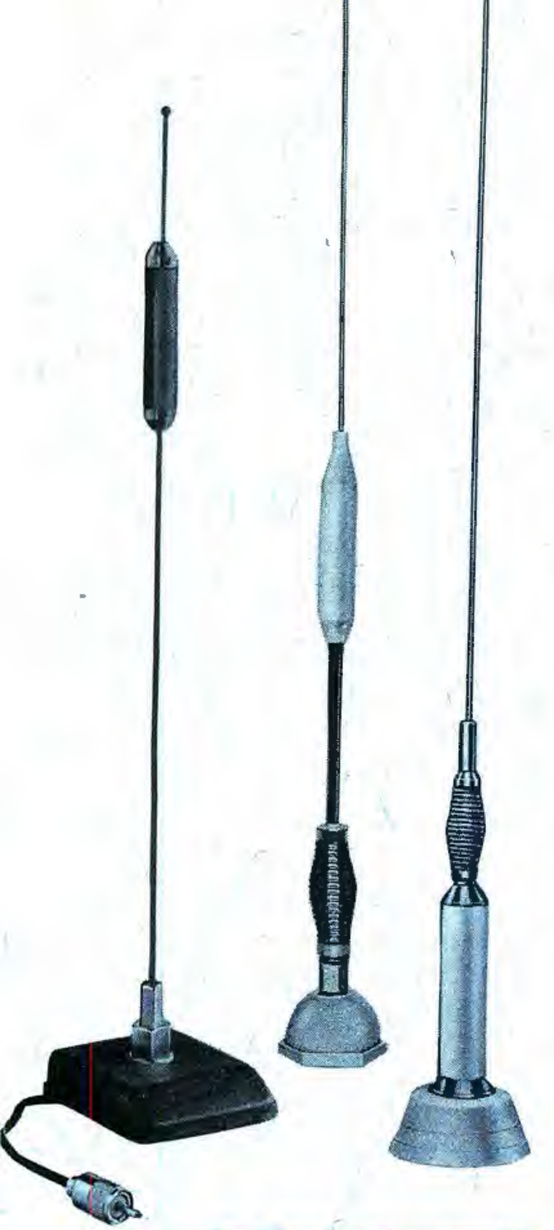


Fig. 3. Top-loaded antenna (A) is shown at left; center loading (B) in middle; base loading (C), right.

fiberglass whip is vulnerability to impact from overhanging objects.

A stainless steel shock spring can be inserted at the base of a long whip to make it more shock absorbent. The spring must have a braid-shorting strap fastened internally between its two ends. Otherwise, the spring will act as a coil and upset the feedpoint impedance of the antenna.

Types of Loading. An antenna designer has three choices as to the location of the loading coil—at the base, in the center, or at the top of the whip. Each has advantages and disadvantages, and we will examine them in turn.

Base loading is shown in Fig. 3C. The plastic cylinder at the base of the antenna houses the loading coil, isolating it from the detuning and corrosive effects of the environment. Base loading requires the least amount of inductance for a given antenna length, so coil resistance can be kept to a minimum. Also, base loading results in a physically sturdy structure because the weighty loading coil is at the bottom of the antenna. The light weight of the whip minimizes pendulum-like oscillations. An electrical benefit is also obtained. Keeping the coil fixed in relation to the ground plane reduces variations in feedpoint impedance as the whip flutters.

Most antennas that employ base loading are at dc ground. That is, there is a direct short from a dc point of view between the whip and the ground plane. Dc grounding is introduced to bleed off the hiss-producing static charges that accumulate on a stainless steel whip before they can discharge into the atmosphere.

The major disadvantage associated with base loading is a distortion in the distribution of voltage and current along the radiating element. Compare Fig. 4A, the V-I distribution along a full-size vertical radiator, with Fig. 4B, the distribution along a base-loaded antenna. This distortion in voltage and current distribution means that the base-loaded antenna has a fairly low radiation resistance—lower, in fact, than that exhibited by center- or top-loaded whips. Radiation resistance, a concept developed by antenna theorists, is a fictitious resistance that accounts for the power radiated by the antenna. The higher the radiation resistance, the greater the portion of the r-f delivered to the antenna that is actually radiated into space. Base loading, therefore, is less efficient than other loading techniques.

Center loading (Fig. 3B) offers improved V-I distribution along the radiator and greater radiation resistance than base loading. However, for a given whip length, more loading inductance is required. This implies greater coil losses than those experienced with base loading. There is a compensatory factor: a base loading coil is situated at the current maximum, but a center loading coil is positioned at a point where there is less current in the radiator. Heat losses are determined by the familiar relationship $P = I^2R$, where I is the rms current and R the dc resistance of the coil. That less current flows in a center loading coil compensates, somewhat, for the greater resistance of the larger loading coil.

Top loading (Fig. 3A) improves the V-I profile and increases the radiation resistance even more. This loading technique requires the most inductance and thus introduces the most coil resistance. However, the top of the radiator is where the least current flows, so coil losses are not as severe as you might first think. The trade-off of some coil losses for increased radiation efficiency is more than a break-even proposition.

The real problem that center or top loading introduces is whip sway. This adversely affects the radiation pattern and causes variations in feedpoint impedance. Whip sway is more likely with center or top loading because the coil housing increases the wind resistance of the whip. Impedance variations are more severe than with base loading because the relationship between the ground plane and the loading coil is not fixed but dependent on the deflection of the whip. As mentioned earlier, whip sway can be prevented by making the antenna rigid, but again, a stiff upright radiator is more susceptible to impact damage. However, if an antenna up to about 60" (1.2 m) is mounted on an auto roof or trunk, the likelihood of its coming in contact with overhanging objects is not too great. Vans and trucks are a different story.

Another loading technique is *continuous loading*. No discrete loading coil is employed. Rather, the inductance is distributed along the entire radiator. The continuously loaded antenna is formed by helically winding one quarter-wave length of wire on an insulating pole (Fig. 5). Epoxy or a fiberglass sheath is used to secure the helix in place.

Continuous loading produces better voltage and current distribution than lumped constant (discrete coil) loading. It's feedpoint impedance is also a better match for 50-ohm coax. If a tapered pitch is employed when the helix is wound, a very good match will be obtained. The radiation resistance of a continuously loaded antenna is comparable to that of a top-loaded whip. Because of these advantages, many of the fiberglass antennas on the market (except, of course, full-size whips) employ continuous loading.

Mounting the Antenna. We have already seen that a vehicle's body falls short of fulfilling a required ground plane. This has a significant effect on the performance of a mobile whip. Recall that the ground plane is analogous to a mirror. If it has high resistance, it will act like a dirty mirror, giving a faint reflection. If it is too small, the entire image will not fit in it. If the ground plane is not symmetrical, it will act like one of those

trick mirrors in an amusement park, producing a distorted reflection.

The size of the ground plane (the auto body) is fixed once you have acquired the vehicle. There is not much you can do about the resistance of the car body except to ensure that all its components are bonded together by low-resistance, metal-to-metal connections. The one ground plane characteristic you can determine, to some extent, is its symmetry. This is done by your choice of the antenna's mounting site.

The best place to mount a mobile whip is at the center point of the vehicle's body, midway between the front and back and equidistant between the two sides. This will usually be located on the roof of the vehicle. If the antenna is mounted here, it will have a polar radiation pattern like that shown in Fig. 6A. (The arrow points towards the front of the automobile.) Although this pattern is not the ideal circle, it is a fair approximation. Because a car is longer than it is wide, the antenna is more effective fore and aft than it is side to side.

Mounting the antenna on the trunk lid results in the pattern shown in Fig. 6B. The distortion introduced by shifting the antenna from its ideal mounting position is obvious. It is due to the lack of ground plane symmetry. However, the pattern is acceptible and its imperfect shape is considered by many CB'ers to be less objectionable than drilling a hole in the vehicle roof for an antenna mount.

The polar response of an antenna mounted on the left corner of the rear bumper is shown in Fig. 6C. The antenna strongly favors the front right, and its overall performance is degraded. It is clear from these plots of field strength near the antenna that an unsymmetrical ground plane produces a polar response that is also unsymmetrical. If possible, this should be avoided.

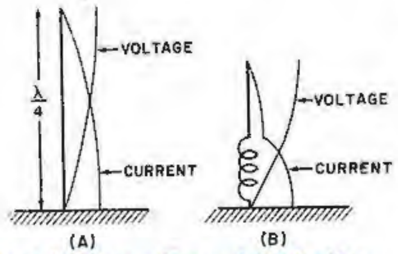


Fig. 4. Voltage and current distribution along a full-size quarter-wave antenna (A) is distorted when a loading coil is introduced at base of antenna (B) and the whip length is reduced.

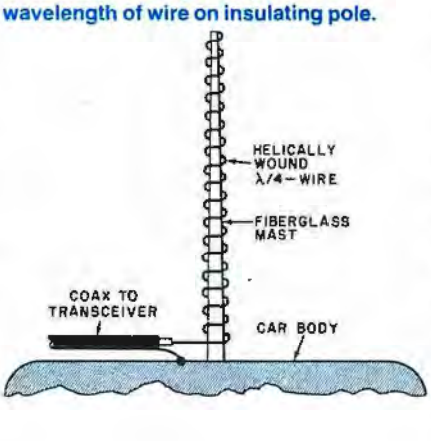
Types of Mounts. CB'ers can choose either permanent or temporary antenna mounts. The final decision will be guided by performance, theft protection, and aesthetic considerations.

Permanent mounts include hardware-secured roof, trunk-lid, and bumper installations. Roof mounts require a 3/8"-to-3/4" (9.5-to-19-mm) hole, but offers the best antenna performance. Trunk-lid mounts do not require drilling because they are held in place by two set screws which grip the inside edge of the trunk lid. As noted earlier, antenna performance is somewhat degraded as compared to roof mounts. Bumper mounts usually employ straps which wrap around the bumper. The new "safety bumpers," however, have a lip which allows a clamp mount to be used with no straps or chains. Bumper-mounted antennas will not perform as well as those on the trunk or roof. The same is true of mirror- and cowl-mounted whips.

These permanent antenna mounts offer a solid connection to the ground plane, which is desirable, but they present security problems.

You can minimize calling attention to your CB gear by either removing the antenna and its mount each time you leave the car. (A quick-disconnect device is useful for this purpose) or by using antennas that are self-stowing. Using a multi-purpose antenna for AM and FM reception as well as for CB work is one way to do this. Such "disguise" antennas, if properly designed, look like a standard auto antenna. Electrically powered antennas that retract at the touch of a switch (some actuated by turning off the transceiver or ignition) similarly reduce the risk of loss while adding to convenience. Some of these, though, still leave a tell-tale 1/2" jutting through the opening. "Hideaway" trunk mounts, hinged to allow the antenna to be swung down into the trunk when not needed, also reduce antenna visibility.

Fig. 5. Continuously loaded antenna is made by winding one-quarter wavelength of wire on insulating pole.



Though these anti-theft measures reduce the chance of theft, they do degrade antenna performance somewhat. Because "disguise" antennas are mounted on a fender, and "hideaway" trunk mounts must be placed along one side of the trunk, they work against an unsymmetrical ground plane and have a skewed polar pattern.

Antennas with temporary mounts include those that clip on the rain gutter and those with magnetic mounts. There are several disadvantages associated with gutter mounts. First, gutters are not sturdy so the antenna must not have large wind resistance. This dictates the use of short whips and large loading coils, resulting in coil losses and decreased antenna efficiency. Second, rain gutters do not always have low-resistance connections to the rest of the car body (ground plane). Third, the ground plane is highly unsymmetrical.

A magnet-mounted antenna can be effective both as a radiator and an anti-theft device. It can be tossed in the trunk when not needed, and placed on the trunk or roof in a few seconds. A good magnet-mount antenna meets the following requirements. It must resist being dislodged when the whip is deflected. It must not "walk" along the roof or trunk as the car body vibrates and the whip sways. The mount must display a relatively high capacitance to the car body. The last requirement is electrically important because a magnet mount, unlike the others that have been mentioned, does not offer a direct connection to the vehicle body. Although the braid of the coaxial cable is grounded at the transceiver, for best results it should also be grounded at the mount. If the magnet mount is properly designed, there will be sufficient capacitance between it and the vehicle body.

No matter what type of mount you are thinking of using, be sure that it will keep the antenna upright. For example, if you are mounting the antenna on a fastback or other angled surface, choose a mount that will permit you to compensate for the mounting angle and adjust the whip so it is upright.

Co-Phasing. If two vertical antennas are spaced one quarter wavelength or

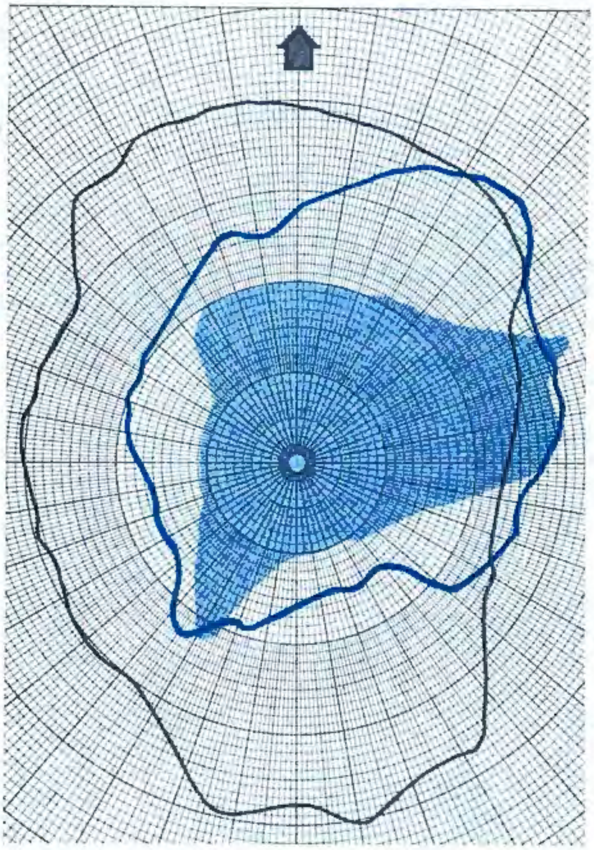


Fig. 6. Polar radiation patterns for roof (black line), trunk (colored line), and bumper (solid color), mounted antennas. Arrow points toward the front of the vehicle.

more away from each other, fed with properly phased feedlines, and there are no vertical conductors within a two-wavelength radius, some gain and a figure-eight radiation pattern (favoring fore and aft) will be obtained. CB'ers have attempted to take advantage of this by mounting twin whips on truck or camper mirrors, car bumpers, etc. Unfortunately, it doesn't work! Except, perhaps, on some very large trucks, a whip spacing of 104" (2.6 m) cannot be obtained. Also, there are enough intervening metallic elements within two wavelengths (72.8' or 22.2 m) to upset the carefully phased electromagetic fields.

The two mirror- or bumper-mounted antennas together will, however, have a better polar response than one by itself (recall Fig. 6C) because of the complementary phasing between them. But one antenna mounted on the vehicle roof or trunk displays a pattern superior to that of the phased twins, and will usually give superior performance!

Antenna Materials. Choosing a given type of loading, mounting position, etc. must be guided by factors that are unique to a given situation. Therefore, we can't recommend a specific antenna type. But we should say a word about antenna materials. If you want a metallic whip, be sure that it is "17-7 PH" type stainless steel. This alloy is very strong, does not corrode, and will flex but is resistant to permanent deformation. Shock springs and similar components should be triple-chrome plated.

Finally, mounting hardware should be heavily plated to resist corrosion.

In Conclusion. A properly installed and tuned antenna is your transceiver's best friend. Therefore, take care to mount it so that its ground plane is symmetrical. Make sure that the antenna has provisions for adjusting its length so that it can be fine tuned for the CB channels. Tune the antenna in accordance with the manufacturer's instructions and you'll ensure that it and your transceiver are giving you their maximum performance capabilities. ◇

How to Install

• Mobile CB Transceivers
• Mobile CB Antennas

BY IVAN BERGER
Senior Editor

WANT to make $25 or more, tax-free, for about an hour's easy work? Then install that new CB mobile radio in your car yourself, and you'll save at least that much. You don't need special knowledge or unusual tools.

You can mount a CB transceiver almost anywhere within reach of the driver's seat and mount an antenna almost anywhere outside the car. But it pays to look first for the best and easiest places to install them. For example, be sure that there is sufficient room under your dash to accommodate the transceiver's depth *before* you buy it!

For a typical mobile setup, we'd recommend that the transceiver be mounted on a quick-release slide bracket beneath the center of the dash. Also, the antenna should be mounted so it can be flipped down into the trunk for concealment when necessary. That combination offers easy access to the set's controls, reasonably good signal output and reception, straightforward installation, and excellent theft protection.

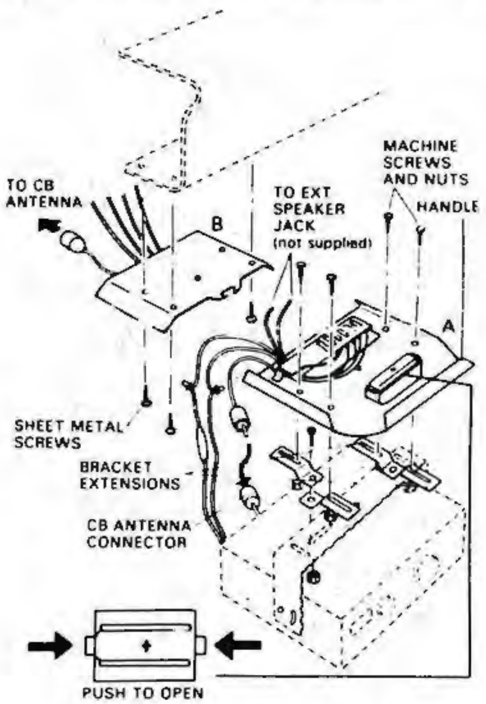
The reasons for the dashboard site are obvious: next to a combo CB/stereo unit that's built into your dash (and such equipment is difficult to install), a centered, under-dash mount is easiest for both driver and passenger to reach and is least likely to get in anyone's way.

Slide mounts come in two parts: a stationary section that attaches to the bottom part of the dashboard, and a sliding section that holds the transceiver. Ideally, you'll find a mounting spot for the stationary section where the transceiver's controls will be easy for every driver in your family to see and reach, where the rig can be easily and securely mounted, and where there will be space to install the rig with clearance for attachment of its plugs and fasteners.

Mounting Surfaces. With a little bit of luck, you may find some screws already on the underside of the dash that can be used to hold the slide or the transceiver's mounting bracket (although you might have to replace those screws with slightly longer ones). If not, check the available surface to be sure it is strong enough to carry the transceiver's weight and to determine what techniques will be needed to drill through it.

Plain, painted metal is an ideal surface. It can support the radio securely and you can use short, self-tapping sheet-metal screws. With an electric drill, clean holes are easy to make. Just be sure to mark each hole with a center-punch before you drill so the bit won't slip while you're working and scratch the paintwork—or your skin.

Metal with a padded covering requires a bit more care when drilling. Fabric covers or wooly underpadding may wrap themselves around your drill bit. Even foam padding, although less of a problem, must be treated cautiously.



A typical 2-part slide mount for easy removal of an under-dash CB transceiver. Note that copper finger contacts on part A (that attaches to transceiver) makes power and signal connection to part B (affixed to underside of dashboard) so that the user need not physically disconnect or connect wires to remove unit.

If you can, it's best to punch your way through a padded metal underdash. An alternative approach is to cut an "X" in the top covering where you want to make the hole, peel back the four flaps made by the cut, and carefully dig or cut out any underpadding. Then smear Vaseline on the bit to make it slippery and drill in short bursts, watching carefully so you can stop the drill at the first sign of cloth or padding wrapping itself around the bit. After installing anything on a padded surface, check and re-tighten the screws from time to time to compensate for any gradual compression of the padding.

Plastic and fiber panels are less secure mounting surfaces than metal, but sometimes they're all you have. Check behind such panels to see if there are metal structural supports that you can reach with longer bolts or screws. If not, the main problem is a tendency for the transceiver's weight to cause screw holes to enlarge until the screws pull out, CB rig and all. To prevent this, drill very carefully, with a sharp, fresh bit and gentle pressure to avoid cracking the panel. Then spread the weight over as much surface area as possible, using several, widely spaced screws and placing the largest possible washers under each nut. (Use lockwashers or Loctite to prevent your mountings from vibrating loose.) If you can't get your fingers behind the panel to insert nuts and washers, use Molly screws. For screw holes near the edge of a thin panel, Tinnerman nuts can hold the mounting bolts, although larger washers will spread the load more.

If your mounting surface is an underdash, plastic parcel shelf, rest your rig atop the shelf instead of hanging it below; here, the screws only maintain the transceiver in position, rather than supporting its weight.

Before you drill the first hole, make a final position check: Have someone hold the slide and transceiver in place and check for such often-overlooked details as cords that might get tangled in the gear-shift or pedals, side-mounted microphone plugs that poke the driver's leg, etc. Double-check behind the dash to make sure the drill bit won't hit wires, puncture air-conditioning ducts, or hit ashtrays. Often you can move some of the obstacles out of the way before you drill. If they are not too close to the panel you're drilling, you can also protect them by slipping a drill stop (available at hardware stores) over the bit to limit the depth of its penetration, or improvise a stop with duct tape. Otherwise, you'll have to pick a new location.

Determine which half of the slide mount attaches to the car and use it—not the mounting bracket supplied with the transceiver—as your template. (The transceiver bracket then bolts to the other, sliding half of the mount.) Make sure the bolt heads don't protrude enough to prevent sliding the transceiver into place. After you have drilled the first hole, attach your bracket to the car and double check the position you've marked for the second one.

Other Mounting Spots. If your dashboard is not a suitable or convenient spot for your transceiver, you might consider mounting it on the car's transmission hump. It's best to use speaker/rig-mount combinations in this situation. They're designed specifically for floor use, incorporating better speakers than those in mobile units. Moreover, since most mobile rigs have downward-facing speakers, this accessory avoids a sound-output problem. They usually disconnect easily for storage in the trunk when not in use, but they do take up some floor space.

Although the dash and the hump are the most popular locations for a CB rig, they are not the only ones. Some CB'ers

mount their sets, controls up, between front bucket seats; others mount them in their cars' center consoles. A small transceiver can even be installed in the car's open well that serves as a glove compartment. Then, too, there are temporary setups where the rig rests on the seat, lifted at the edge so as not to muffle speaker output. Power here is obtained from a lead plugged into the cigar lighter socket, while the antenna is either attached to a rain gutter or by a magnet mount in the middle of the roof.

Many new transceivers are built for concealment, with all controls in the microphone head and the rest of the circuitry in a featureless box that can be locked in the trunk or hidden elsewhere (mounted on the firewall, for example).

Extension Speakers. Most mobile sets have one or two extension speaker jacks on their rear panels. These allow the use of external speakers for better sound within the car, for PA use outside the car, or both. In rigs with two jacks, one feeds the stations you are listening to through an extension speaker in the car, while the other, when you switch the transceiver to its "PA" mode, feeds whatever you say into the mike through a speaker outside the car or under its hood. Don't use hi-fi car-stereo speakers since their frequency range is too wide for voice radio communications, which rarely exceed 3 kHz.

Slide-Out Bracket Details. Not all slide mounts are alike (although some models may show up under several brand names). Insist on a bracket that has a built-in coaxial socket and plug for the antenna, so you don't have to disconnect that separately when you slide out the transceiver. If you don't have this feature, you're sure, someday, to forget to re-attach the antenna and blow your power transistors.

The flimsy locks often found on slide mounts don't discourage thieves, who can often snap them in seconds. Even if the lock is a robust one, why invite a thief to try and rip up your car? So it's best to throw away the key and remember to remove and store your rig, perhaps in the trunk, when you leave the car unattended.

Most slide-mount sets have an extra pair of contacts for extension or PA speakers. At least one has two pair, so you can use both extension *and* PA speakers with your transceiver, or use the same mount for a car stereo (which needs connections for two speakers).

Installing a mobile CB rig is not usually a major undertaking. It can be challenging, though, when an AM/FM electric-powered antenna is replaced by a CB/AM/FM one since auto radio must be removed to make power connections.

Power Connections. Your mobile transceiver will get its power from the car's electrical system. It's easiest to make these power connections while the transceiver is in the car, but before it's actually bolted in place. You may connect it either to a circuit that is always "live" or to one which only carries power when the ignition key is turned. The owner's manual for your car should tell you which circuits are which and may—especially if it's a foreign car—include a circuit diagram to help you find the wires you'll need.

Running the power leads to a switch-controlled circuit ensures against accidentally draining the battery by leaving the car with the transceiver turned on. It also prevents unauthorized use of the radio while you're out of the car. (Remembering to remove and hide the rig each time you get out would also take

This external speaker-system/CB-rig mount is positioned on top of the car's transmission hump for enhanced sound. It is removable and can be hidden in the trunk for safety.

care of these two problems.) If you want to listen or transmit with the engine off, most car's ignition switches have "accessory" positions to allow this.

The easiest place to connect the CB power leads is to one of the terminals or wires already in the dash. You can tap into an existing wire, to a terminal of the ignition switch (if that's not buried out of reach), or to a terminal on one of the other dashboard switches or controls. (If you do use a switch terminal, make sure you have the switch's "hot" side—you don't want a CB radio that only operates if the headlights are on.)

The best place to tap in is usually the car's fuse box—there's less chance of picking up interference there. Whether you get your power directly from the fuse box or from another power source under the dash, make sure the fuse involved has enough capacity to handle your transceiver plus other devices it's already powering. If not, select a circuit with some spare capacity—don't just install a larger-amperage fuse. And never connect your transceiver or other accessory to the same circuit as the headlights or other vital systems.

Which Side is Ground? Virtually all cars today have 12-volt electrical systems, with the negative side of the circuit grounded to the car's frame. But some older ones and many trucks have positive-ground systems. Most current transceivers will operate on negative-ground, 12-volt systems, with many also capable of working on positive-ground systems. The instruction manual accompanying the CB transceiver will note which type you have. But if you don't have that information, you can use the ohmmeter function of a multimeter to determine it. Measure resistance between the transceiver's case and each of its two power leads. If you read zero ohms or very low resistance between the negative (usually black) lead and a bare metal area or screw on the case, your radio is for negative-ground use only. If the positive (usually red) lead is connected to the case, the transceiver is suitable only for positive-ground systems. But if you read high resistance between the case and both leads, you can use that radio with either grounding system as long as you connect the wires properly.

If you don't know which system your car uses, you can usually tell just by looking at the battery to see which of its terminals is connected by a woven-wire strap to the car's chassis; this would be the ground side.

The fuse block will sometimes have an unused tab to which you can attach a slip-on "quick disconnect" terminal that crimps onto your radio's power lead. If there are no unused tabs, you may be able to find an adapter that combines two male tabs with one female quick-disconnect. Remove the wire now connected to the tab on the fuse box, slide the adapter's female connector over the tab and one of the adapter's male connectors into the wire's female terminals. This leaves an extra tab to which you can attach the wire from the transceiver. Some fuse blocks may have screw terminals instead, or points to which you can solder your power wire.

If you have to splice into an existing wire, there are several possible ways of doing so. Auto-parts and electronic stores often stock small connectors from 3M and AMP which can be used to splice a lead into an existing wire without cutting it. The only tool needed to attach these is a common slip-joint plier. If you have to cut and splice wires, make sure the joint is mechanically strong, soldered if possible (those new, rechargeable cordless soldering irons are very handy for this), and properly insulated. (Heat-shrinkable plastic tubing is ideal for this purpose.)

Once your rig is connected to the car's electrical system, you'll want to try turning it on to make sure it lights up. Do this *after* you've rechecked the wiring for correct polarity—but *don't press the microphone's talk button* until the antenna system is connected! Transmitting without the antenna's load can damage output transistors.

Antenna Locations. In most CB installations, the antenna cable must run from a transceiver near the driver's seat to an antenna at the rear of the car. Peo-

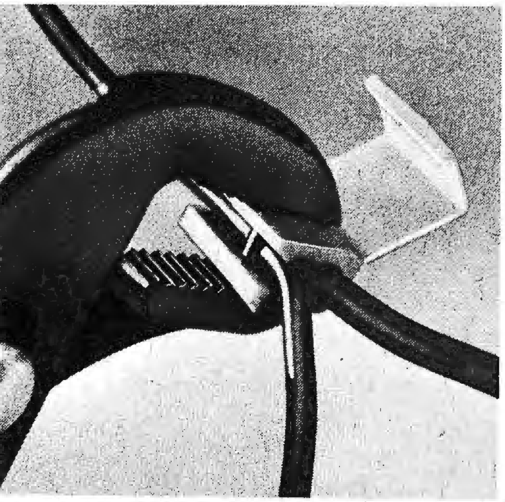
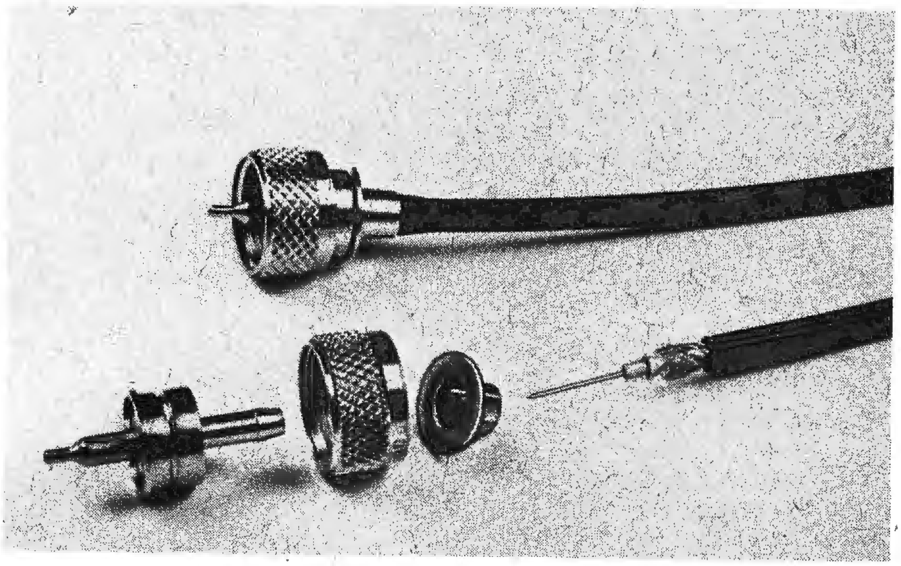
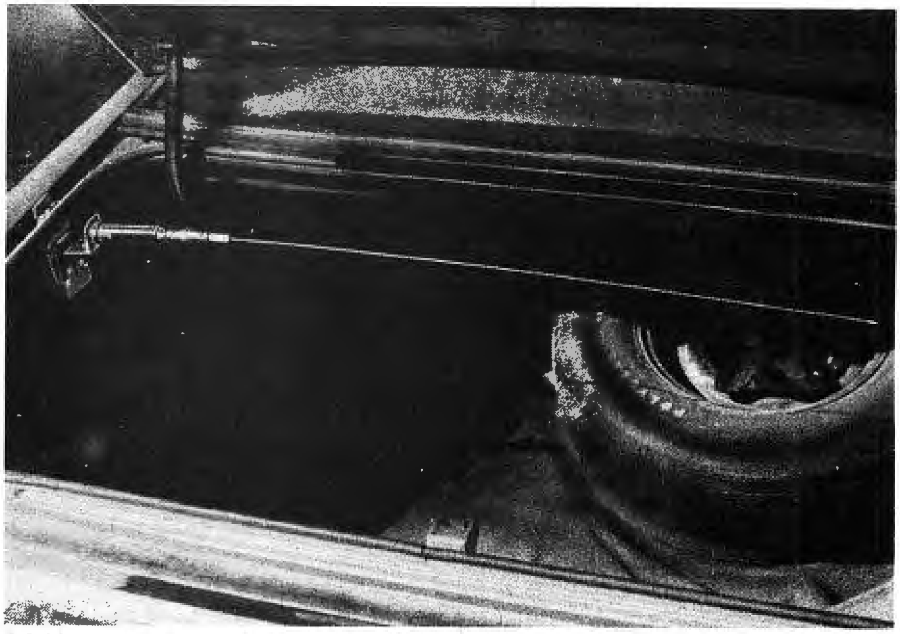


Photo at left shows a new type of 3M connector that comes in handy for making power connections to your mobile CB rig. Below, is an Amphenol PL-250 plug to show how easily RG-58A/U antenna coax wire can be connected without soldering.



ple mount their antennas back there for a variety of reasons. One is that short, coil-loaded antennas that clamp onto the trunk lid are about the easiest to install, since no holes have to be drilled in the car's outer body. Also, an antenna mounted to the front, hinged edge of the trunk is in a fairly efficient location, especially if the car's a hatchback with its "trunk lid" hinged at roof level. Nine-foot whip antennas can only be mounted conveniently on a car's rear bumper.

Antennas serve to alert would-be thieves that there's probably CB equipment inside that is worth stealing. So more and more installations take this into account. Quick-disconnect attachments are often used for easy removal of the vertical antenna section, though this still leaves the antenna base. To completely hide an antenna, more and more CB'ers have turned to the electric-powered type or to an antenna mounting device that permits one to manually swing the antenna down into the trunk. Both are side-mounted types.



A fold-away trunk mount makes it easy to conceal a mobile CB antenna when leaving an automobile.

Flip-down mounts may clamp on, without drilling, or may require some small screw holes in the rain gutter that surrounds the trunk opening. Since signal radiation from a mobile antenna is greatest toward the farthest point of the car, mounting the antenna by the side of the trunk opening will send most of your transmitted power towards the car's opposite front corner. But there will still be substantial radiation in most directions, so that is not a serious problem—especially compared to the performance you get if your rig is stolen!

Whether you have a trunk mount, a bumper-mounted whip, or a flip-down, your biggest problem will be getting its lead out to the transceiver. You're most likely to run your antenna cable from the trunk toward the dash.

Getting the lead into the trunk should be easy. Bumper-mount whips may require a hole drilled in the trunk wall (remember to line it with a rubber grommet, both to protect the cable and keep rain out), although it is sometimes possible to bring the cable through a hole that now carries wire to your back-up or license-plate lights. Antennas that mount on the edge of the trunk opening require only a little care to ensure that the cable won't kink when the lid closes.

Coming from the trunk, your first obstacle will likely be the partition between the trunk and the passenger compartment. If there's a gap between the partition and the trunk's floor, or if the car is a wagon or hatchback whose seat folds down, half the problem is already solved for you. You may also find a channel that carries tail-light and other wires, with enough space left to carry your antenna cable too. More often, though, you'll have to make a hole. If the partition is of metal, you'll have to drill. If it's of fiberboard or a similar substance, you may be able to punch a hole through it instead. It's probably best to drill, using gentle pressure. Again, be sure to line the hole with a rubber grommet. Check out the area on the other side of the panel before locating the hole to be sure your drill won't chew into upholstery or encounter other problems where it comes through. If the rear seat cushion has to come out, it's generally best to do that first. (It may take two people to do this.) Most seats are held by catches, some by bolts.

Before drilling, you should also check the passenger compartment to see where it will be best to run the cable. The best route is usually along the side of the car. You can tuck it under the edges of side panels (you may have to loosen their mounting screws), run it under the sill-plates at each door (they're easy to remove, usually held by just a screw or two), or insert the cable under the edges of the carpets and floor mats. In some cases, it's more practical to lift the carpets and run the cable along the lower edge of the transmission hump and through the center console.

If you are unable to remove the rear seat cushion, you could try to snake the wire straight through the trunk, or fish it through with a hook made from coat-hanger wire. If that fails, try raising the seat's front edge enough to get your hand under it. (You may want to slip a block beneath the seat's front edge.) If the seat doesn't lift up easily, check on how it's mounted; it may be bolted in place.

As you work, you should be using cable clamps or cable ties to keep the antenna lead out of the way. This is most important in the trunk where a loose cable could be snagged by luggage or other cargo, and when passing across the front of the car where it could tangle with the steering gear or pedals.

The antenna cable may not be exactly the right length, but that's no problem. If it's too long, you can cut the excess and use a new PL-259 connector. The solderless connector type for RG-58 A/U coaxial cable is best for this purpose.

If the cable is too short, you can buy an extension. Buy one with plugs already installed and the shortest length that will do the job.

Other Antenna Sites. Because your signal's coverage increases as you raise your antenna, and because its pattern is most symmetrical when the antenna is at the center of the car, a roof mount is a most efficient choice. Unfortunately, a roof mount can be quite difficult to install. Also, most people hesitate to drill holes in an area that is so conspicuous.

For a roof antenna, you'll have to drill a hole in the roof and snake the antenna lead from there, under the car's cloth

headliner, then down a window pillar to the dash or floor level. That may be easier if you have a dome light in the center of the car's roof—take out the light and you can usually drill directly through the roof. Just be sure there will still be room to put the light back, once the antenna is installed. If you have no center light, you'll have to take the headliner down to do the job neatly—and in most cars, that's not easy.

You can also use a magnetic-base antenna. It requires no drilling and installation (the cable could be passed through the rubber gasket around the car's door opening or through a slightly opened window). Furthermore, the antenna is easily hidden in the car when you park.

Antennas that clip temporarily to the car's roof gutter are available, too, as are permanent fender-mounted or cowl-mounted types. The latter include electric-powered antennas, which might also combine AM and FM broadcast radio.

Fine-Tuning Your Antenna. It's not enough to just install and connect your antenna. You also have to adjust it for minimum SWR—standing wave ratio. This is the ratio between the power that comes out of your transceiver and the lost power that bounces back from the antenna line instead of going out over the air. (It will similarly affect the strength of a received signal.)

To do this, you'll need a modestly priced SWR meter, if your CB transceiver doesn't have one built in. This will reduce some of the savings you made by doing your own installation, but is a worthwhile investment for making periodic checks on your antenna system.

The meter plugs in between the transceiver and the antenna cable. If you have added an extension to your antenna's cable, you can connect the meter between the cable and extension. Otherwise, you'll need a short stub of cable with plugs on both ends to connect the meter to your transceiver; some meters include this cable, but not all do.

You can't tune an antenna for the same SWR on every channel. The farther you go in frequency from the channel for which the antenna has been tuned, the higher the SWR will be. So, unless you do almost all your talking on a single channel, you should tune the antenna to the center of the band for the best average efficiency on all channels.

For 40-channel transceivers, this would be channel 20 or 21. Listen for a break between conversations before you press the mike "talk" button. You don't want to interfere with other CB users' conversations! Also, you may legally transmit a silent carrier only when making adjustments like this and then for not more than one minute out of every five.

Measuring and adjusting for minimum SWR is an important final step to ensure optimum antenna efficiency and avoid damaging a CB transceiver.

Your meter will probably have a switch marked FWD on one side and REV or SWR on the other. Switch it to the forward position and press your mike's talk switch. The needle should move up the scale. Adjust the meter's calibration knob until the pointer reaches a red line or other index mark. Then flick the switch back to SWR or REV and read the pointer again. It should have dropped back to a reading somewhere between 1.1 and 1.5 or so. Now release your PTT mike switch so you can make antenna adjustments that will produce the lowest SWR reading.

Theoretically, an SWR of 1:1 is perfect; in practice, it will be higher, say, 1.2:1 at mid-channel and 1.5:1 to 2:1 at end channels.

To lower an antenna's SWR, you must adjust its length. This requires either lengthening or shortening the antenna. To tell which, repeat your SWR checks on a moderately low channel (around channel 10) and a fairly high one (say, channel 30). If SWR is lower on channel 10 than channel 20, you'll have to *shorten* the antenna; if it's lower on channel 30 than on 20, you'll have to *lengthen* it. (If it is much higher than 2:1 on any channel, stop transmitting on that channel at once and check cable connections at the transceiver and the antenna ends.)

Most of the better antennas have length adjustments, either an adjustable tip (on top- or center-loaded antennas or on some fiberglass "continuously loaded" types), or an adjustment on the coil housing (of base-loaded types). To lengthen or shorten such an antenna, simply loosen the adjustment setscrew with the Allen wrench supplied, make a small height adjustment, and lock it in place while you re-check your SWR with the meter.

Less expensive antennas and some older types may have to be trimmed to obtain a proper match. Either a hacksaw or bolt cutter will do the trick. Cut no more than ⅛ inch at a time.

Eventually, your SWR will get as low as it's going to be and your next adjustment will only serve to raise it a trifle. At that point, go back one step to where you got your lowest reading. Then, for a final check, measure your SWR on both channel 1 and channel 40. If they're not quite equal, readjust until they are.

Now, at last, you're ready to go on the air and ask for a radio check. ◇


SQUELCH
SIGNAL
VOLUME
MODE
TONE
SYNTH
HEATHKIT
HW-2036
LOCK
AUX
+600
SIM
-600
OFF
A
B
C

BY RAY WILKINS

FOUR EASY-TO-BUILD LED PROJECTS

WITH THE prices of LED's and CMOS IC's continuing to drop, electronics experimenters should take advantage of the circumstances and build some of the many interesting projects that can be made using these devices. The four circuits described in this article are not only fun to build, they also teach the builder quite a bit about the devices and their uses.

The circuits take advantage of the fact that CMOS devices require very low power, so no power on/off switches are used. The quiescent current drawn by the CMOS chips (when the LED's are off), allows normal battery shelf life. Once the pushbutton switch on a project is operated, the circuit "does its thing," and then stops.

Blinker. As shown in Fig. 1, this circuit uses a single CMOS hex inverter to provide both timing and drive to make the two LED's blink alternately. Built with two small red LED's, the circuit makes

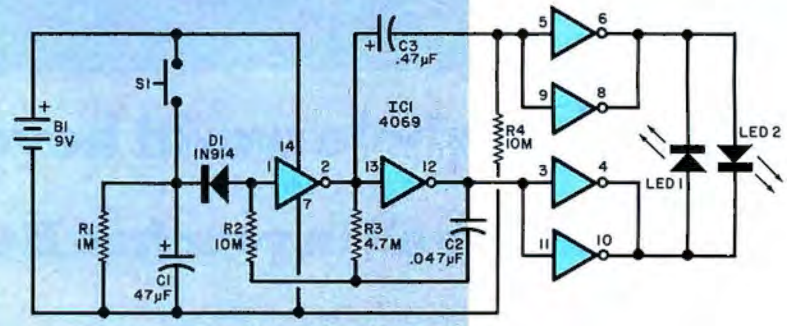


Fig. 1. Dual LED alternate blinker uses parallel gate output for more LED driving current.

BLINKER PARTS LIST

B1—9-volt battery
C1—47-µF, 10-V electrolytic
C2—0.047-µF disc capacitor
C3—0.47µF, 10-V electrolytic
D1—1N914 diode
IC1—4069 CMOS hex inverter
LED1, LED2—Light emitting diode (2 red, or 1 red/1 green)
R1—1-megohm resistor
R2, R4—10-megohm resistor
R3—4.7-megohm resistor
S1—Normally open pushbutton switch

an ideal HO-gauge model railroad crossing blinker. With LED's of two different colors (in one package), it can be used to obtain other effects.

Resistors *R2* and *R3* and capacitor *C2* determine the flash rate, while *R1* and *C1* set the total display time. The component values shown here produce a blinking rate of two per second and an on time of about 20 seconds. To change the timing, change the values of the capacitors since decreasing the value of the resistors will increase the quiescent battery current drain.

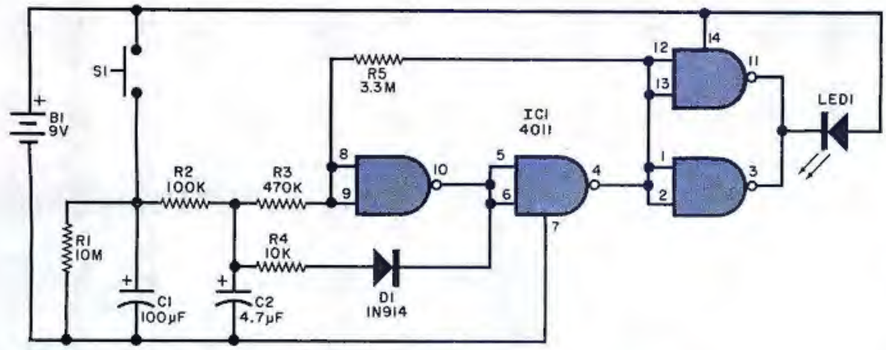


Fig. 2. Single LED flasher also uses parallel gate output for driving the LED.

FLASHER PARTS LIST

B1—9-volt battery
C1—100-µF, 10-V electrolytic
C2—4.7-µF, 10-V electrolytic
D1—1N914 diode
IC1—4011 CMOS quad 2-input NAND gate
LED1—Red light emitting diode
R1—10-megohm resistor
R2—100,000-ohm resistor
R3—470,000-ohm resistor
R4—10,000-ohm resistor
R5—3.3-megohm resistor
S1—Normally open pushbutton switch

Flasher. A simple variable-rate LED flasher is shown in Fig. 2. The voltage across *C1* determines the flash rate. When the pushbutton switch is closed, capacitor *C1* charges to 9 volts and the flasher blinks rapidly. As the voltage is discharged through *R1*, the flasher slows down until the charge on *C1* reaches about 4.5 volts, at which point the oscillator stops and the LED stays off. The flash rate is set by the values of *R2*, *R3*, *R4*, *R5*, and *C2*. Capacitor *C1* and bleeder resistor *R1* create the slow-down period.

Binary Counter. A circuit that demonstrates the operation of a six-bit binary counter is shown in Fig. 3. When the

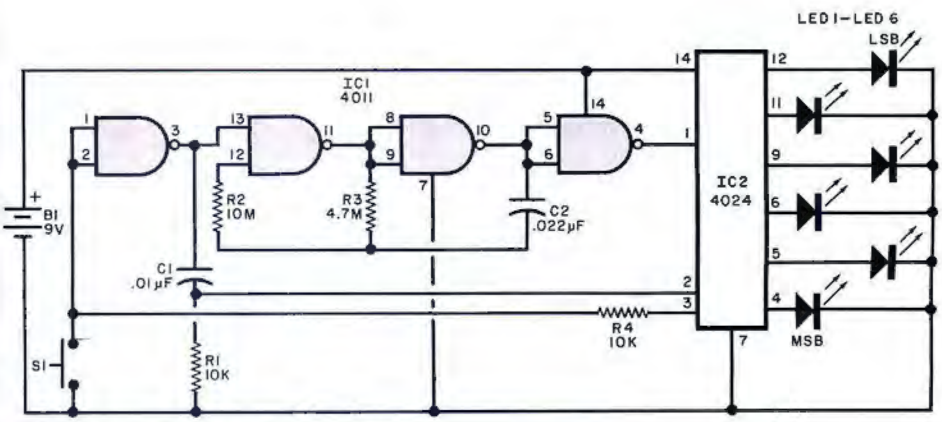


Fig. 3. Simple binary counter illustrates counting in the 1-2-4-8-16-32 mode.

BINARY COUNTER PARTS LIST

B1—9-volt battery
C1—0.01-µF disc capacitor
C2—0.022-µF disc capacitor
IC1—4011 CMOS quad 2-input NAND gate
IC2—4024 CMOS binary counter
LED1-LED6—Red light emitting diode
R1, R4—10,000-ohm resistor
R2—10-megohm resistor
R3—4.7-megohm resistor
S1—Normally open pushbutton switch

pushbutton switch is depressed, the circuit starts counting from zero (all LED's off) to 63 (all LED's lit). After reaching the full count, the circuit automatically resets to zero and shuts itself off. The six LED's come on in a binary (1, 2, 4, 8, 16, 32) sequence which is typical of digital counters.

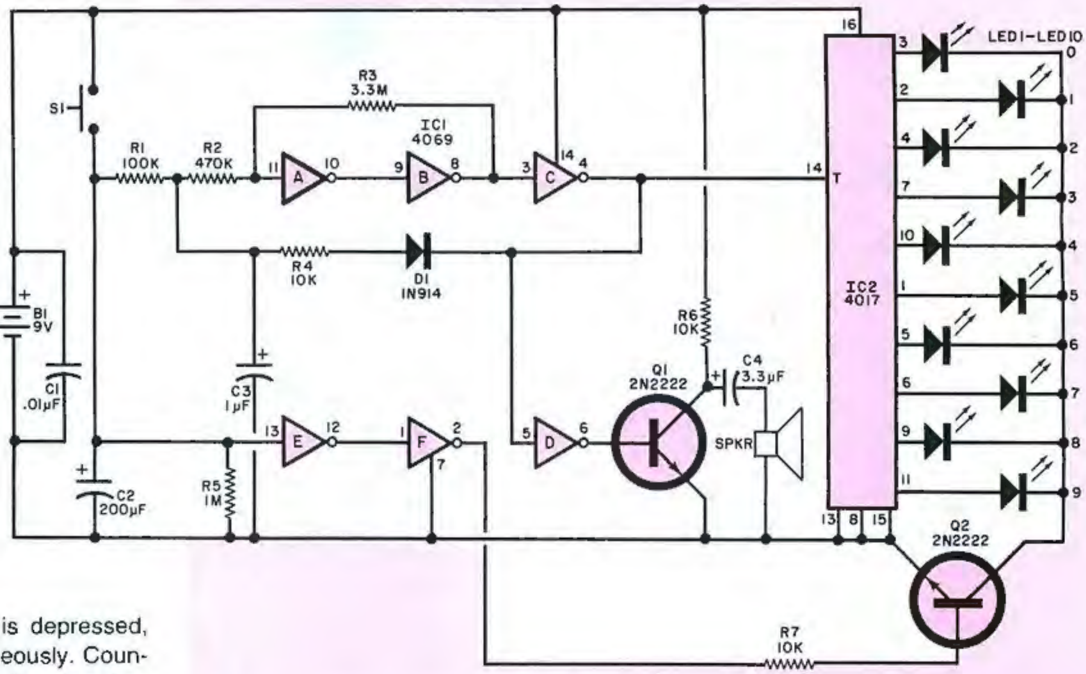


Fig. 4. "Wheel of Fortune" sequentially lights one of 10 LED's and generates audible clicks.

When the pushbutton is depressed, two things occur simultaneously. Counter *IC2* is reset to zero by the signal on pin 2, thus placing all of the *IC2* outputs at their low states (0 volts). Thus, none of the LED's can glow. The second action is an enable level signal (+9 volts) at pin 13 of *IC1*. This action allows the oscillator (the middle two gates) to start, thus producing an input signal to the counter IC through the last gate of *IC1*.

The counter then counts until it is full, illuminating the LED's in the proper sequence. One count after full count is reached, pin 3 of *IC2* goes high. This signal is inverted by the first gate of *IC1*, and its output goes low, thus disabling the oscillator. The circuit then remains in the "all LED's off" state until the pushbutton is depressed again. The value of *C2* can be changed to increase or decrease the counting speed.

Wheel of Fortune. The circuit shown in Fig. 4 is a 10-LED spinning wheel with audible 'clicks' as the wheel passes each point. The rotation starts fast, then gradually slows down to a random stop (with a click at each position). After the rotation ceases, the selected LED stays lit for about 10 seconds, then goes out. The cycle restarts by depressing the pushbutton switch.

The logic requires only two IC's. Of these, *IC1A*, *IC1B* and *IC1C* form a vari-

WHEEL OF FORTUNE PARTS LIST

B1—9-volt battery
C1—0.01-µF disc capacitor
C2—200-µF, 10-V electrolytic
C3—1-µF, 10-V electrolytic
C4—3.3-µF, 10-V electrolytic
D1—1N914 diode
IC1—4069 CMOS hex inverter
IC2-4017 CMOS decade counter decoder
LED1-LED10—Red light emitting diode
Q1, Q2—2N2222 transistor
R1—100,000-ohm resistor
R2—470,000-ohm resistor
R3—3.3-megohm resistor
R4, R6—10,000-ohm resistor
R5—1-megohm resistor
S1—Normally open pushbutton switch

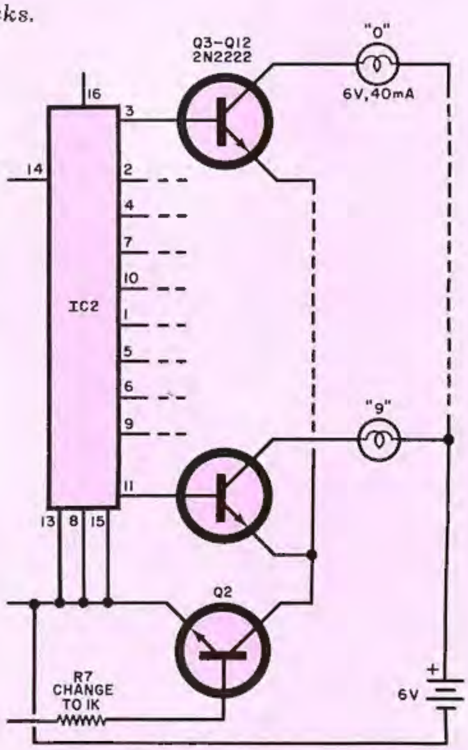


Fig. 5. Modifying the Wheel of Fortune for use with conventional 6 volt lamps.

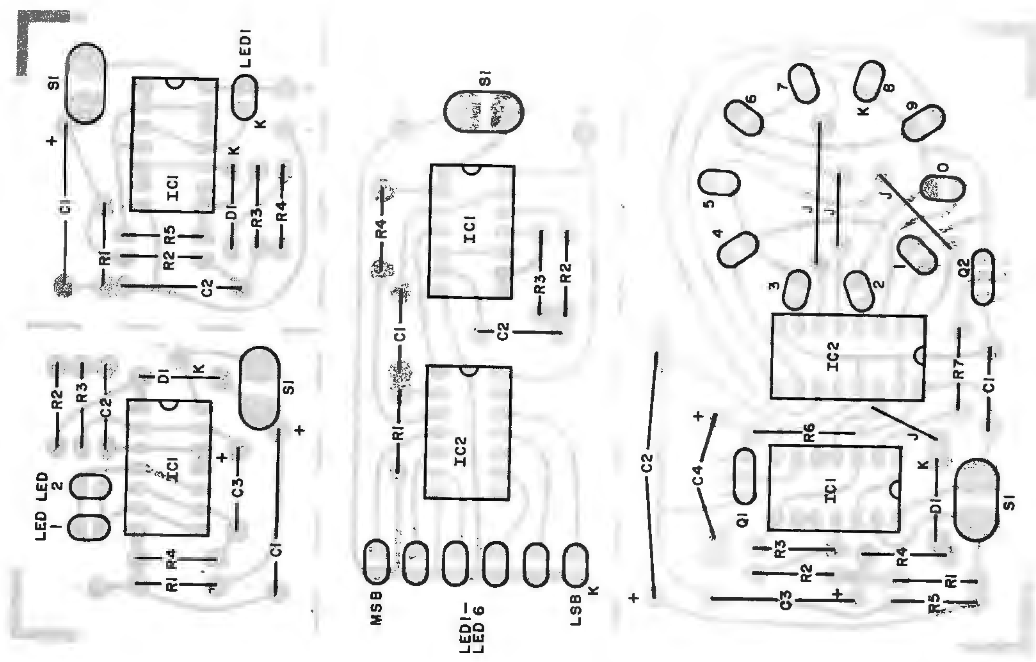
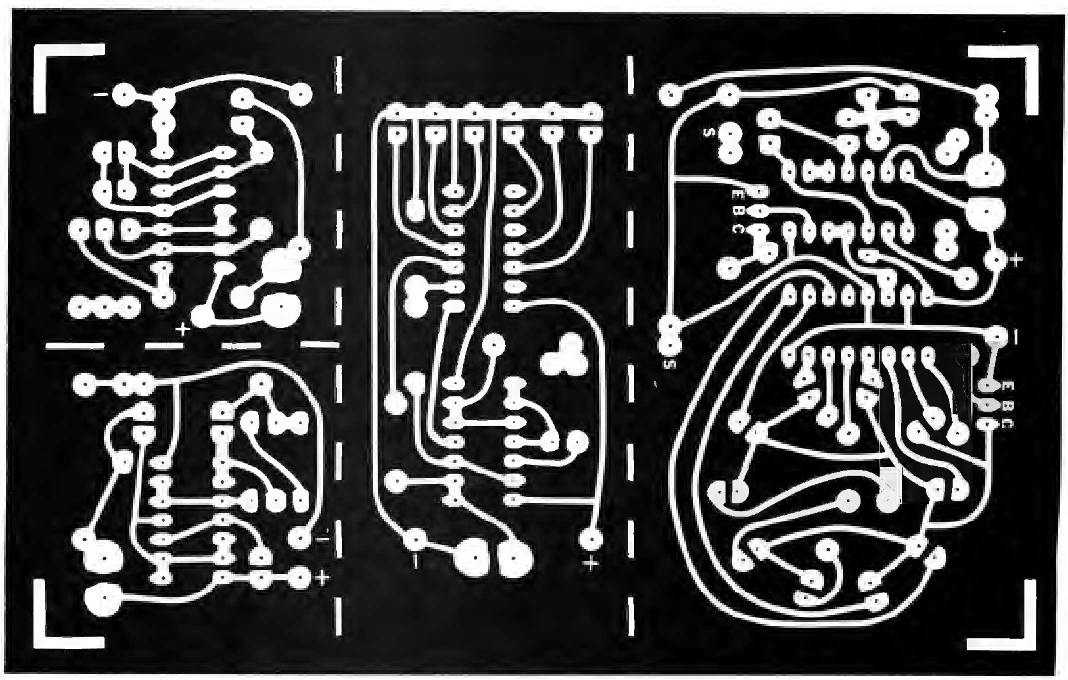


Fig. 6. Foil pattern and component installation. The four circuits are separated along the dotted lines.
Note: Pc board available from Ray Wilkins, Box 551, Hanover, NH 03755 for $4.50 ppd.



able frequency oscillator operating exactly like the oscillator in the Fig. 2 flasher circuit. Then *IC2* is a combination decade counter, decoder and driver that powers 10 LED's in sequence, with the LED's arranged in a circular display. Each pulse from the oscillator advances the count by one.

The oscillator pulses are buffered by *IC1D* and amplified by transistor *Q1* to drive a small loudspeaker. Capacitor *C3* affects the speed of rotation, while *C2* determines the total length of time that the display stays lit. The dc voltage across *C2* is also applied to a pair of buffering inverters (*IC1E* and *IC1F*) with the output used to turn on switching transistor *Q2*. When this transistor is saturated, it allows the LED's to turn on. When the voltage across *C2* drops, the output of inverter *IC1F* drops to zero, causing *Q2* to cut off, thus turning off the LED's.

It is possible to substitute conventional 6-volt, 40-mA lamps in place of the LED's by using the circuit shown in Fig. 5. To operate these optional lamps, an extra 6-volt battery is required.

Construction. Any type of construction can be used for any of the projects. If you want to use a printed circuit, you can use part or all of the foil pattern shown in Fig. 6. The four sections of the pattern can be separated at the dotted lines. Component layouts are also shown in Fig. 6. Install passive elements first, then the IC's. Be sure to observe the polarities of the electrolytic capacitors, diodes and IC's. Use a conventional 9-volt battery clip and leads for the connections. The red lead is positive, and the black lead is negative. ◇

Experimenter's Corner

By Forrest M. Mims

GETTING ACQUAINTED WITH CMOS

THOSE OF YOU who have built some of the digital circuits presented in this column over the past several months have probably noticed a problem common to all the 7400-series TTL integrated circuits. They are power hungry. The 7489 64-bit RAM, for example, typically draws 80 milliamperes. Some 7489 chips require up to 120 milliamperes. That's one-fourth of the current demand of a 6-volt lamp in a portable sealed-beam lantern!

One way around the TTL power problem is to use low-power Schottky TTL chips. These chips typically require only twenty percent of the power of conventional TTL. Low-power Schottky devices, which aren't as easy to find and cost more than conventional TTL, are designated with an "LS", such as: 74LS89, 74LS90, etc.

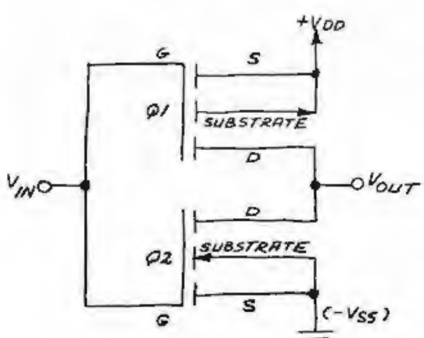


Fig. 1. Basic CMOS gate.

The best solution to the TTL power problem is to use CMOS IC's instead. In case you're not familiar with CMOS, it's a logic family which uses voltage-sensitive, metal-oxide semiconductor (MOS) field effect transistors, as opposed to current-sensitive, bipolar transistors.

CMOS has an ultra-low power requirement. The CMOS 74C89, for example, is functionally almost equivalent to the TTL 7489 64-bit RAM. The CMOS version, however, typically consumes only 0.050 microampere in operation! This power saving feature makes CMOS ideal for battery-powered devices like digital watches, pocket calculators, and spacecraft.

Why does CMOS require so little power? The answer lies in the very structure of CMOS circuitry. A basic CMOS gate (an inverter) is shown in Fig. 1. Note that a *complementary* (the "C" in CMOS) pair of enhancement-mode MOSFET's comprise the inverter. (Although other CMOS logic elements are more complex, they all use complementary MOSFET's and the following description captures the essential characteristics of the CMOS logic family.) An enhancement MOSFET is normally off, displaying a high resistance between drain and source. To turn it on, you must apply a sufficiently large voltage between the gate and source.

In this circuit, *Q1* is a p-channel MOSFET and *Q2* is an n-channel device. The two form a series circuit between V_{DD} and ground. If V_{IN} is low, the p-channel MOSFET is on and the n-channel MOSFET is off. Thus, *Q1* exhibits a relatively low resistance between drain and source and *Q2*'s channel resistance is very high. The output terminal is therefore effectively connected to $+V_{DD}$ and isolated from ground, and V_{OUT} is high. If V_{IN} is high, there is no potential difference between the gate and source of *Q1*, so the p-channel MOSFET is off. However, V_{GS} for *Q2* is high, and the n-channel device turns on. This grounds the output terminal, making V_{OUT} low.

Note that in either case (V_{IN} high or low), one MOSFET is on and the other is off. Because the two devices are connected in series, a high-impedance path exists between $+V_{DD}$ and ground for either input state. That's why CMOS requires so little supply current. In fact, the only time its current demand rises is during an input state transition (V_{IN} going towards $+V_{DD}$ or ground). During such a transition, the devices will have channel resistances between the two extremes and more current will be drawn from the source.

Among the other advantages to using CMOS are the small chip area required for each gate, the very high noise immunity, the large fan out (the number of CMOS gate inputs that can be driven by one output), a wide range of permissible power supply voltages, and low output, and high input impedances. There are a few drawbacks, however. A MOSFET's gate structure is very fragile, and the extremely high input impedance makes CMOS susceptible to damage from static electricity. Also, CMOS employs both p- and n-channel MOSFET's in close proximity to each other on the same chip. This makes CMOS more costly to manufacture than conventional TTL, which employs npn transistors exclusively. Finally, the structure of CMOS results in relatively large stray capacitances, which combined with high input impedances result in relatively slow logic. The typical maximum speed for CMOS logic is 1 to 5 MHz.

In many applications, high speed isn't required and CMOS is perfectly acceptable. The other major problem with CMOS, its vulnerability to static electricity, has been dealt with by diffusing protective zener diodes at the sensitive gate structures. The diodes shunt high voltages away from the gates, preventing their destruction. However, you may not know if a particular device is diode-protected, and external appearance will not tell you. Unless you know for a fact

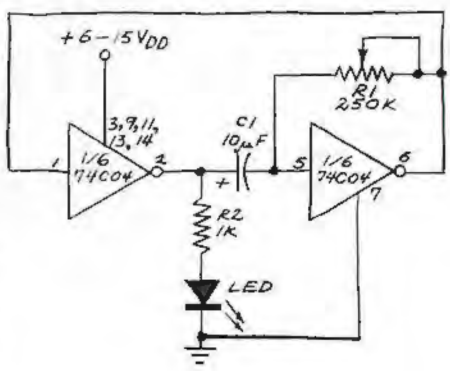


Fig. 2. Astable multivibrator.

that a particular CMOS device is protected, play it safe and handle it carefully.

In recent years a wide range of CMOS chips has become available at prices attractive to the experimenter from many of the advertisers in the Electronics Marketplace pages of this magazine. One common family is a pin-for-pin equivalent of the traditional TTL 7400 series. These chips even use the same num-

bers, inserting a "C" after the 74 prefix. Thus, a 74C00 is the CMOS version of the TTL 7400. Another common CMOS family is the 4000 series. Let's use a chip from each family in test circuits.

CMOS Astable Multivibrator. A good way to become better acquainted with CMOS is to build a simple astable multivibrator from a few of the inverters in a 74C04 hex inverter. One possible circuit is shown in Fig. 2. This circuit will flash its LED at ample brightness while consuming only a few milliamperes from the four series-connected 1.5-volt alkaline AA cells. Excepting current through the LED, the circuit consumes less than half a milliampere.

The circuit's repetition rate can be varied by adjusting the setting of *R1*. Naturally, current demand goes up when the pulse rate is increased.

Avoid touching the pins of the 74C04 when you build the circuit. CMOS chips that do not have diode protection are almost always sold with the pins inserted in conductive plastic foam (*not* styrofoam) or with the pins otherwise shorted together to prevent damage from static electricity. Grasp the ends of a CMOS DIP between your forefinger and thumb, and then insert it into a solderless breadboard. Use insulated connection wires,

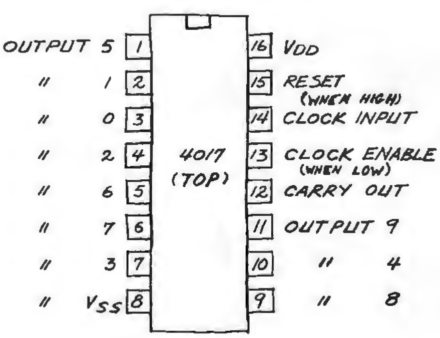


Fig. 3. Pin outline of the 4017. Each activated output goes high for one clock cycle then returns to the low state.

and avoid touching exposed conductors. (You'll want to take more elaborate precautions when handling expensive CMOS chips such as microprocessors.)

Incidentally, CMOS chips can be operated from a power supply delivering from 3 to 15 volts, so feel free to use a higher supply voltage.

CMOS Divide-by-10 Counter/Decoder. The 4017 CMOS divide-by-10 counter/decoder is an exceptionally handy chip. It does the job of a 7490 TTL decade counter *and* a 7441 TTL 1-of-10 decoder. Figure 3 shows the pin outline for this versatile IC.

We can put the astable multivibrator we just built to work by using it as a source of clock pulses for the 4017 counter. Figure 4 shows one possible arrangement in which the 4017 successively flashes each of ten LED's. Only one LED series resistor is needed since only one LED is on at any given instant.

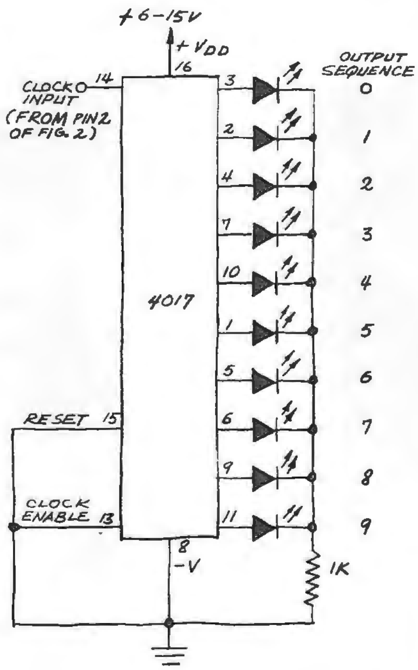


Fig. 4. Sequence generator.

Can you think of any applications for the 74C04 clock/4017 counter? If you adjust the clock so that it supplies one pulse each second, you can use the circuit as a handy darkroom timer. The circuit also makes an unusual light flasher or attention getter. Just arrange the LED's in a circle or in a random pattern and adjust for the best visual effect.

Another application for the circuit is as a sequence generator. I originally designed the circuit as a microinstruction sequencer for a homebrew digital controller made from a dozen or so TTL chips. The TTL drew so much current from my power supply that it was necessary to use CMOS for the sequencer circuitry. Since the controller was designed to operate at relatively slow operation (below 100 kHz), CMOS was the logical choice in this case.

Another excellent way to learn more about CMOS is to read Don Lancaster's *CMOS Cookbook* (Howard W. Sams & Co., Inc., 1977). This 414-page book is filled with useful tips, applications and design possibilities. ◇

When you shop around for tires, you look for a bargain. After all, if it's the same brand, better price—why not save money?

Education's different. There's no such thing as "same brand." No two schools are alike. And, once you've made your choice, the training you get stays with you for the rest of your life.

So, shop around for your training. Not for the bargain. For the best. Thorough, professional training to help give you pride and confidence.

* * *

If you talked to some of our graduates, chances are you'd find a lot of them shopped around for their training. They pretty much knew what was available. And they picked CIE as number one.

Why you should shop around yourself.

We hope you'll shop around. Because, frankly, CIE isn't for everyone.

There are other options for the hobbyist. If you're the ambitious type—with serious career goals in electronics—take a close look at what we've planned for you at CIE.

What you should look for first.

Part of what makes electronics so interesting is it's based on scientific discoveries—on ideas! So the first thing to look for is a program that starts with ideas and builds on them!

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson takes one or two principles and helps you master them—before you start using them!

How practical is the training?

This is the next big important question. After all, your career will be built on what you can do—and on how well you do it.

Here are ways some of CIE's trouble-shooting programs help you get your "hands-on" training...

With CIE's Experimental Electronics Laboratory... you learn and review the basics—perform dozens of experiments. Plus, you use a 3-in-1 precision Multimeter to learn testing, checking, analyzing!

When you build your own 5 MHz Triggered-Sweep, Solid-State Oscilloscope you take your first real professional step. You use it as a doctor uses an X-ray machine—to "read" waveform patterns... lock them in... study, understand and interpret them!

When you get your Zenith 19-inch Diagonal Solid-State Color TV you

Pattern simulated.

apply your new skills to some real on-the-job-type trouble-shooting! You learn to trace signal flow... locate malfunctions... restore perfect operating standards—just as with any sophisticated electronics equipment!

When you work with a completely Solid-State Color Bar Generator—actually a TV signal transmitter—you study up to ten different patterns on your TV screen... explore digital logic circuits... observe the action of a crystal-controlled oscillator!

Of course, CIE offers a more advanced training program, too. But the main point is simply this:

All this training takes effort. But you'll enjoy it. And it's a real plus for a trouble-shooting career!

Do you prepare for your FCC License?

Avoid regrets later. Check this out before you enroll in any program.

For some troubleshooting jobs, you must have your FCC License. For others, employers often consider it a mark in your favor. Either way, it's government-certified proof of specific knowledge and skills!

More than half of CIE's courses prepare you for the government-administered FCC License exam. In continuing surveys, nearly 4 out of 5 CIE graduates who take the exam get their Licenses!

Shop around... but send for CIE's free school catalog first!

Mail the card. If it's gone, cut out and mail the coupon. If you prefer to write, mention the name and date of this magazine. We'll send you a copy of CIE's FREE school catalog—plus a complete package of independent home study information! For your convenience, we'll try to have a representative contact you to answer your questions. Mail the card or coupon—or write: CIE, 1776 East 17th St., Cleveland, OH 44114.

CIE Cleveland Institute of Electronics, Inc.
1776 East 17th Street, Cleveland, Ohio 44114
Accredited Member National Home Study Council

☐ **YES...** I'm shopping around for the **right** kind of career training in electronics troubleshooting—and CIE sounds well worth looking into. Please send me my FREE CIE school catalog—including details about troubleshooting courses—plus my FREE package of home study information!

PE-60

Print Name ____________

Address ____________ Apt. ______

City ____________

State ____________ Zip ______

Age ______ Phone ____________ (area code)

Check box for G.I. Bill information: ☐ Veteran ☐ Active Duty

Mail today!

Hobby Scene Q&A

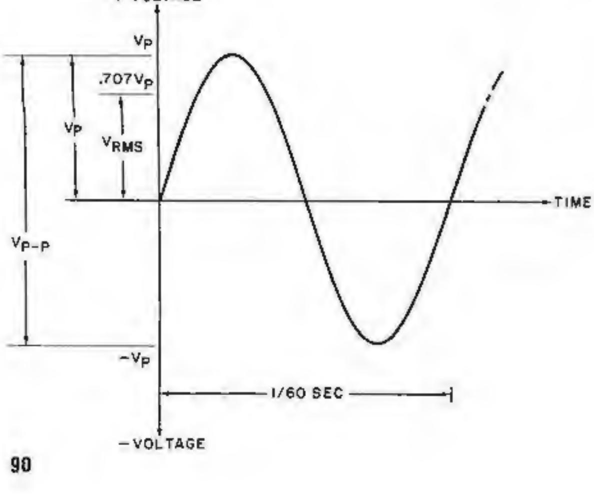
By John McVeigh

Have a problem or question on circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.

"AC VOLTAGES"

Q. ***I would like to know if commercial power is 110 volts peak or working voltage.—Paul Coelho, Mill Valley, CA.***

A. An alternating voltage (terms like "ac voltage," "ac current," "dc voltage," etc. are really misnomers) can be expressed in several ways. The wave-form delivered by commercial power companies is sinusoidal, similar to the waveform shown in the figure. Such a wave can be described by its peak voltage V_P, the highest (or lowest) voltage the waveform attains during one cycle. It can also be described by its peak-to-peak voltage V_{P-P}, which, in the case of a symmetrical waveform, is twice the peak voltage. Finally, it can be described by its "working," "effective," or root mean square (rms) voltage, which is the square root of the mean value of the square of the instantaneous voltage. Strictly speaking, it is not the average value of the voltage, which for a sine wave is zero (the positive and negative portions of the signal cancel each other out in straight averaging). In non-mathematical terms, the rms value of a signal is the voltage required to produce the same amount of energy (say, heat dissipated by a resistor) that a steady direct voltage would. For a "110-volt" sine wave from a commercial power station, the rms voltage V_{RMS} is 110 volts, the peak voltage V_P is $\sqrt{2} \times 110$ volts or 155.6 volts, and the peak-to-peak voltage V_{P-P} is 311.2 volts.



CW BANDPASS FILTER

Q. ***I need a sharp audio bandpass filter for CW reception. Do you have one that peaks around 800 Hz?—Dean Poeth, WB8TMD, Columbus, OH.***

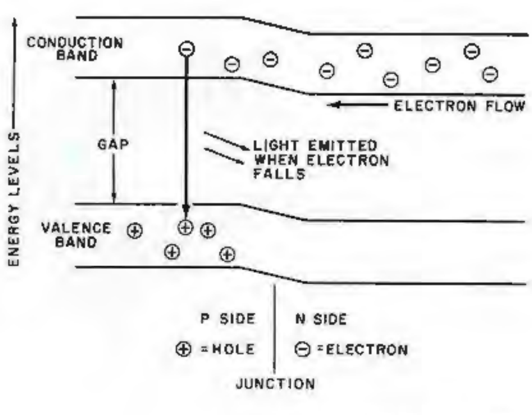
A. The best circuit I have on hand is the input stage of the Morse-A-Letter, the Morse decoder which appeared in the January 1977 issue. This circuit is not only an active bandpass filter, but has excellent agc characteristics as well. You could use a low-impedance earphone in place of the speaker at edge connector location *A8*. Of course, the digital circuitry can be omitted if you want to decode the Morse yourself!

HOW AN LED WORKS

Q. ***Why does a light emitting diode emit light, and why just one color?—Lou D'Antuono, Queens, NY.***

A. A LED is similar to a germanium or silicon diode in that it is composed of semiconductor material. On one side of the semiconductor *junction,* the material contains impurity atoms with extra electrons as compared to the majority material. These excess electrons are not bound into the crystal lattice structure, and will move with a little push. This side is called the n side. On the other or p side, impurity atoms are added that are deficient in electrons as compared to the majority atoms. Thus there are "slots" in the bounding structure called holes into which electrons can fall. The excess electrons occupy a "conduction band" and have higher average energies than the electrons in the "valence band" on the p side.

Forward biasing a pn junction pushes electrons from the n side to the p side, where they fall from the conduction band into the valence band (into holes). Any electron that falls into the valence band gives up energy in the form of heat or light. The process is shown in the figure. The wavelength of the emitted electromagnetic energy depends on the gap between the two bands. The wider the gap, the more energy is given up, and the higher the frequency (shorter wavelength) of the emitted radiation. If the gap is sufficiently wide, the radiation will be in the visible spectrum. The width of the gap depends on the material used to form the diode. That's why only one narrow group of wavelengths (color, in the case of visible light emitters) is radiated by a particular diode. Gallium Arsenide (GaAs) or Gallium Arsenide Phosphide (GaAsP) is used to form most LED's.



Product Test Reports

SUPERSCOPE AIRCOMMAND AM CB TRANSCEIVER

Features LED meter readouts, channel-9 scan and SWR indicator.

THE Superscope Aircommand 40-channel mobile AM CB transceiver departs from convention, as do a few others, by indicating relative signal strength, output power, etc., with a row of LED's instead of a meter. Another special feature is channel 9 scanning with individual squelch control and an audible alarm that sounds whenever a signal appears on channel 9.

Aside from its special features, the Aircommand has a Delta tune control with center detent; individually switched automatic noise limiter (ANL) and noise blanker (NB); detachable microphone with a headphone connection at the mike plug; bottom-facing speaker; PA mode; external-speaker jacks; auxiliary input jack for feeding output from a portable radio or tape player through the transceiver's audio section; and electronic voltage regulation. It operates from a 12-to-16-volt dc, negative- or positive-ground source.

The transceiver measures 9 1/16" D × 7 9/16" W × 2 7/16" H (23 × 19.2 × 6.2 cm). It comes with mobile-mounting hardware and rubber feet for base station installations and carries a suggested retail price of $229.95

Technical Details. Although a schematic diagram was not supplied with our test transceiver, we were able to surmise the following details. The receiver employs double conversion to i-f's of 9785 and 455 kHz. A filter at the second i-f provides the selectivity. The circuit lineup consists of the customary r-f amplifier, mixers, i-f amplifiers, detector, agc, squelch, audio ANL, and audio amplifier stages. (The last doubles as the modulator for the transmitter.)

The PLL system follows the usual pattern. It uses a 10,240-kHz crystal-controlled oscillator from which the standard reference signal is derived. This oscillator is also used for the second conversion, using the difference between its frequency and that of the first i-f. The voltage-controlled oscillator (vco) at the first mixer operates at a frequency 9785 kHz below the CB signal to minimize the possibility of high receiver radiation above 28 MHz and to insure better image rejection.

The transmitter's carrier is derived from the vco, the signal from which is routed through the r-f amplifiers and the driver and power-output amplifiers. A multielement output network matches to 50-ohm loads and minimizes spurious responses and harmonics that might otherwise cause TVI and other service interference. Amc is included in the transmitter to maintain high average modulation without excessive overmodulation that could cause adjacent-channel splatter.

The RF GAIN and audio VOLUME and the DELTA TUNE and SQL (squelch) controls on the transceiver's front panel are arranged in concentric pairs. Although the SWR CAL control appears to be a concentric pair, it is actually a single control. The other functions are handled by lever-type switches located in the lower center of the panel. The switch at the left is for selecting between PA and CB operation. The next three toggles are for switching in and out the noise blanker (NB), for Channel 9 SCAN/HOLD/OFF selection, and for switching in and out the ANL. The last switch is for setting the LED display to indicate relative SWR in its up position and relative output power (PWR) in its down position and for calibrating the system in the center (CAL).

Just right of center on the front panel is a horizontal row of eight discrete red LED's. The one on the left is a power ON indicator. The next four LED's are labelled for relative power or SWR at 1.5, 3, 5, and 10. The sixth LED is labelled CAL for SWR and is additionally used with the last two LED's to indicate modulation level. Calibration labelling below the LED's is for relative signal strength starting with S4 and ending with S9 + 20 dB. The lowest SWR that can be indicated is 1.5; if the low-end LED does not come on, it is assumed that the SWR is less than 1.5:1.

The red seven-segment numeric LED displays used for the channel indicator are located directly below the row of discrete LED's. The channel selector switch dominates the right end of the front panel.

With the channel-9 lever in the OFF position, normal channel selection is via the channel selector knob. With the switch in the SCAN position, channel 9 comes up only when a signal is being received on this channel, at which time a CH9 LED at the upper right of the panel comes on and a beeping tone sounds. By placing the switch in its HOLD position, channel 9 is kept open.

Laboratory Measurements. The sensitivity of the receiver measured a nominal 0.5 μV for 10 dB (S + N)/N with 1000 Hz at 30% modulation. The agc threshold range was 0.5 to 50 μV. The agc held the audio output to within 7 dB with a 20-dB r-f signal change at 1 to 10 μV and to 10 dB with an 80-dB change at 1 to 10,000 μV. A nominal 50-μV input signal registered an S9 reading.

Adjacent-channel rejection and desensitization was 60 dB minimum. Image and i-f rejection were 75 and 80 dB, respectively. Other unwanted-signal rejection was 60 dB except in the area of 25 MHz, where the rejection was 40 dB.

The overall audio response at the −6-dB points was 500 to 4000 Hz. The audio output was 5 watts with a 1000-Hz sine-wave signal with an 8-ohm output amplifier load. The THD at this output level was 4%. The amplifier was also capable of putting out 6 watts of power at 10% THD and could also be driven into clipping. The PA output was about 10% lower in each test.

Voltage regulation is apparently provided for the transmitter, since the carrier output power maintained a constant 3.75-watt level at any power supply potential between 12 and 16 volts. Such regulation is quite unusual. In all cases, the power gradually drifted down to 3.5 watts after a short period of operation.

With a 1000-Hz signal at microphone input levels 16 to 25 dB greater than that required for 50% modulation, the modulation held to nominally 90% at 2% THD. Under these conditions, the adjacent-channel splatter was down 45 to 50 dB. Using a 400-Hz tone, the THD was 8%. When we switched to a 2500-Hz tone, the splatter was only 38 dB down but still within the FCC regulation.

During operation with maximum voice levels, the modulation slightly exceeded 100% on occasion on the negative and positive peaks. However, the splatter was down 50 to 55 dB. The overall audio response at the −6-dB points was 300 to 3500 Hz. The transmitter's frequency held to within −193 Hz on all channels.

User Comment. The transceiver's performance was startlingly good. Particularly noteworthy was the effectiveness of the ANL and noise blanker. Both performed excellently in our bench tests and in actual on-the-road tests in a noisy vehicle. The audio quality was unusually crisp on receive and of better-than-average quality on transmit. Moreover, the modulation was highly effective. In this respect, we observed that one must take care to avoid speaking too closely into the microphone to avoid "breathy" sounds on the receiving end.

The sophisticated channel 9 emergency scanning function, boasting independent squelch, worked beautifully. It's a most welcome feature.

Although the use of LED's to indicate operating parameters, as on this transceiver, provides only approximate val-

ues, the method can be of more use to the CB'er than the often supplied miniature analog meter movements. Also, the LED's add a colorful and flashy touch to the otherwise bland-looking transceiver.

About the only minor criticism we can make is that the black-finished transceiver's panel markings (though they are white) are difficult to see at night. In addition, the concentric rotary controls are located at the top of the panel, where they protrude far enough to obscure the labelling of the switches below them. The solution to this problem, of course, is to tilt the transceiver upward as is often done in mobile installations.

All in all, we feel this transceiver ranks among the best we have tested.

HAZELTINE MODEL 1500 COMPUTER TERMINAL

Professional terminal in kit form.

AS ACTIVITY in the home microcomputer field has matured, several "big-name" manufacturers have introduced products for use in this new market. One such manufacturer is the Hazeltine Corporation, which is making available its well-known Model 1500 computer terminal in semikit form at a savings over the assembled version's price.

The Model 1500 terminal features an 80-character/line × 24-line format with upper- and lower-case characters. It can be interfaced with a microcomputer via either a 20-mA current loop or an RS-232 system.

The terminal measures 20.6" D × 15.5" W × 13.5" H (52.1 × 40 × 34.3 cm) and weighs 35 lb (15.9 kg). Contact your local store for price.

General Description. The Model 1500 is a classical high-quality terminal. Its character set is displayed in a 7 × 10 dot matrix. Standard and reverse video is provided for all 94 ASCII characters available. The refresh rate is 60 frames per second, noninterlaced, with the display on the built-in 12" (30.5-cm) diagonal glare-proof CRT screen. Dual intensity of any word or character is selectable, and all data is stored in an on-board 2048 × 8 bit RAM.

The terminal also has an on-board ROM that accepts a number of remote (computer-generated) commands. These include cursor address, incremental cursor, read cursor address, clear screen, clear foreground, clear to end of screen, clear to end of line, home cursor, set high/low display intensity, audible alarm, backspace, keyboard lock/unlock, insert/delete line, and remote tab function.

Interfacing with either the 20-mA cur-

Hazeltine's Model 1500 computer terminal comes in semikit form as shown here and is easily assembled.

rent loop or RS-232 system provides full or half-duplex operation, with compatibility with a 103A or 202 modem. Eight baud rates between 110 and 19,200 baud are individually selectable. Also provided is a choice of odd, even, or no parity and a choice of one or two stop bits. All selections are made via a set of DIP switches located under a small lift-off panel near the keyboard.

User Comment. It is difficult to consider the Model 1500 terminal as a kit since its major electronic elements come assembled, tested, and guaranteed by Hazeltine. All that must be done is to follow the assembly instructions given in the well-written manual as the various elements of the terminal are mounted. Then the individual elements are simply interconnected with a solderless wiring harness.

Exercising care in installing the elements and making neat interconnections, we assembled the kit in about four hours, counting from the time we opened the carton in which the kit was shipped. At the end of this time, our terminal was up and running with our computer. The job of assembly is very simple and straightforward; it can be accomplished by anyone who has a rudimentary knowledge of electronics and mechanics. The only hand tools required are a screwdriver and pliers.

Following assembly, the first test we made was to deposit a full screen of m's and w's to test the edge-to-edge clarity of the character display because of the wide bandwidth required to keep the characters from filling in. The full screen of characters also permits checking the linearity of both the horizontal and the vertical portions of the sweep. In our test sample, these were extremely linear and in sharp focus.

When we filled the screen with upper- and lower-case characters, the terminal's character generator, in conjunction with the wide bandwidth, produced an extremely clear display. All keys and key combinations that generate ASCII codes operate in a "typamatic" mode. That is, depressing any of these keys initially produces the selected character on-screen; and, if the key is held down for

more than three-quarters of a second, the character is repeated at a rate of 15 characters per second. In all cases, the terminal displays its characters in a very professional manner, including scrolling. The alphanumeric keyboard and the numeric cluster have finger-tip contoured keytops and a good "touch."

While we were using the terminal, we tried changing the baud rate without changing that of the computer we were using. We discovered that if terminal and computer are not set to the same baud rate, the terminal initiates an insistent "beeping" via its internal alarm and the CRT screen displays a line of PE (parity-error) symbols.

Using the simple instructions provided in the manual that accompanied the kit, we made several changes to a couple of our BASIC programs to permit us to use some of the special remote commands to the terminal (such as screen clear and two-level brightness). Also, using the lock/unlock commands, we managed to defeat the keyboard to prevent anyone's toying with it while a special program was running.

Examining the voluminous and very well-written assembly and operating manual, we discovered that the Model 1500 is more than just a computer terminal. The system is controlled by an 8080A microprocessor and a complete set of support IC's, has internal ROM and RAM, and video display section. With its built-in keyboard, I/O porting, and high-resolution CRT monitor, this excellent terminal can certainly give homebrewers some interesting thoughts on expanding the system.

The manual provided with the terminal kit is by far the most complete we have seen this side of military gear manuals. The maintenance sections are complete, with oscilloscope waveforms, voltage measurements, logic guides, flow charts, etc. There is virtually nothing that can go wrong with the terminal that is not covered by the manual.

If you are a serious computer enthusiast and have spent time and money upgrading your computer system, you should give some thought to moving up to a Hazeltine Model 1500 "professional" computer terminal, especially at its reasonably moderate price. The same goes for small businesses and educational institutions on the lookout for a commercial terminal at a savings in cost.

After working with the Model 1500 for several weeks, we were very favorably impressed with its performance.

Train with NTS for the

MicroComputers, digital
the first name

The world of electronics is daily becoming more challenging. Technology is growing more specialized, and the importance of digital systems increases every day. Test instruments, home entertainment units and industrial control systems are all going digital. And now, NTS training programs include a wider choice of solid-state and digital equipment than ever before offered in any home study course: Advanced NTS/Heath digital color TV (25" diagonal with optional programming capability), NTS/Heath microcomputer, digital test equipment, digital stereo receiver (70 watts per channel), NTS compu-trainer, plus much more state-of-the-art equipment to make your training exciting and relevant.

The equipment you receive with NTS training programs is selected to provide you with a solid background in electronic systems. Kits and lessons are designed to work together to demonstrate electronic principles and applications. The kit-building not only shows you how electronic hardware functions, but how various circuit designs accomplish different purposes. Your lessons guide you through any number of experiments associated with many projects. This is the Project-Method, and it works. Step-by-step, you learn how and why digital electronics has become a part of our world, and the even bigger role it is sure to play in the future.

Whether you are looking for training in Consumer, Commercial, or Industrial electronics, NTS offers fourteen courses, some basic, many advanced, in several areas of electronics. An all-new full-color NTS catalog shows you what each course covers,

electronics of the future.

systems and more...from in home study.

Simulated TV Reception

and every piece of equipment included.

Send for it today, and see for yourself what's really happening in electronics training technology at NTS. Find out how much has changed, and what new directions the field is taking. You'll probably want to be a part of it.

It's free. Just mail the card or coupon. Today.

NO OBLIGATION. NO SALESMAN WILL CALL. APPROVED FOR VETERAN TRAINING.

NATIONAL TECHNICAL SCHOOLS

TECHNICAL-TRADE TRAINING SINCE 1905
Resident and Home-Study Schools
4000 South Figueroa St., Los Angeles, Calif. 90037

NATIONAL TECHNICAL SCHOOLS Dept. 205-048
4000 South Figueroa Street, Los Angeles, California 90037

Please send FREE Color Catalog and Sample Lesson.

- ☐ **Color TV Servicing**
- ☐ **B & W TV and Radio Servicing**
- ☐ **FCC License Course**
- ☐ **Electronic Communications**
- ☐ **Electronics Technology**
- ☐ **Audio Electronics Servicing**
- ☐ **Digital Electronics**
- ☐ **MicroComputers/MicroProcessors**

Name ____________________
Address ____________________
Apartment Number ____________ Age ________
City ____________________
State ________________ Zip ________

☐Check if interested in G.I. Bill information.
☐Check if interested ONLY in classroom training in Los Angeles.

DX Listening

By Glenn Hauser

NON-ENGLISH BROADCASTS TO NORTH AMERICA

THOSE who are not initiated into the world of DX listening often assume one must be multilingual to get anything out of short-wave broadcasts. This is emphatically not the case. Yet, nearly every country that broadcasts in English to North America also broadcasts in its native language and a few use additional languages as well. They deserve your attention, and the native music can be enjoyed with no language barrier.

All these stations send out free program schedules on request. If you don't hear an exact address announced on the air, simply use the station name, city and country. The stations get so much mail that little else is really necessary. Some are reticent about sending schedules in a certain language, unless you write to them in that language. Here's a survey of non-English broadcasts to North America (all times are GMT; frequencies are subject to change.)

Albania. R. Tirana's English broadcasts are so dogmatic and insulting that many SWL's prefer the incomprehensible Albanian. Try 9790, 7300 and 6200 kHz at 0000–0100 and 0200–0230; or 11,985 and 9500 kHz at 1030–1100.

Argentina. RAE English is in three one-hour blocks, exceeded by Spanish at 0000–0300 and 0400–0600 on 9690 kHz weekdays. On weekends, all programs are in Spanish—before 2400 on 11,710 kHz, after 0000 on 9690 kHz.

Australia. Has French for the Pacific at 0000–0100 on 15,320 and 15,160 kHz. Quebec is just a bit farther in the same direction. In our summer, try again at 0500–0600 on additional frequencies in the 16- and 19-Meter bands.

Austria. ORF has German at 2300–0100 and 0200–0330 on 6155 and 9770 kHz; French at 0100–0130; and German at 0400–0430 and 0500–0600 on 6015 kHz.

Belgium. BRT-4 precedes its 0015 English with a half hour of Dutch on the same frequency.

Bulgaria. R. Sofia's 0000 English is flanked by Bulgarian at 2330–2400 and 0100–0130 on the same frequency.

Canada. Among RCI's many French broadcasts audible in North America, these are intended for us: 0100–0127 on 5960 kHz; 0200–0227 on 9605 and 5960 kHz; 0330–0357 on 9535 and 5960 kHz. Listen for a DX show and mailbag on Sundays (GMT Mondays). Spanish: 0030–0057 on 9535 kHz; 0130–0157 on 9535, 6185, and 5960 kHz; 0230–0257 on the same channels as 0300 English.

China. R. Peking in Chinese generally uses frequencies that at other hours are in English. Cantonese is at 0100 and 0300; Standard Chinese at 0200 and 0400.

Cuba. R. Habana Cuba's extensive Spanish schedule is designated for North, Central and South America. If you can't find this, your receiver is turned off! Also, French at 0300–0330 on 11,760 kHz.

Czechoslovakia. R. Prague's "Interprogramme" at 2300–0100 on 9630 and 6055 kHz includes Czech & Slovak at 2300, German at 2330, and French at 0000. Regular broadcasts include Czech & Slovak in the half hour preceding the 0100 English on most of the same channels.

Chile. The Voice of 'Free' Chile uses the same antennas and frequencies for non-English as for English: French at 0000, 0130, and 0300 and Spanish at 0100 and 0230.

Denmark. R. Denmark is stymied by a law that forbids it to broadcast in English! Danish to North America is on 15,165 kHz; most transmissions before 1805 GMT are either for Greenland or North America in general.

Dominican Republic. R. Clarin is in Spanish whenever it isn't in English. Check for a mailbag show at 2230; Sundays after 1500 GMT, hear results of the national lottery—"90 pesos!"—being shouted several times an hour.

Ecuador. HCJB—or the evangelists buying time on it—have the curious idea that it's worthwhile to broadcast to North America in Russian at 0130–0200 in the 19- and 25-Meter bands. Last year there was even Czech. French follows Russian at 0200–0230 on the same frequencies. Spanish comes this way at 1230–1530 on 11,910 kHz; 1630–2100 on 15,160 kHz; 2230–0500 on 11,960 kHz; 0100–0500 on 6050 kHz. Japanese to Japan crosses North America on the way at 1130–1225 on 9715 kHz.

Egypt. R. Cairo follows its English program on 9475 kHz with an hour in Arabic at 0330.

Finland. R. Finland has been ordered to cut its external broadcasts 2 hours and 45 minutes per day. Will this come out of English or Finnish? The latter was scheduled in the hour preceding the 1300 English on the same frequency (exc. Swedish Wed. 1230–1255), and again at 1500–1600 (exc. Wed. 1500–1525 Swedish).

France. Does not use English for North America or any language in our evenings. But at 1200–1710 it's a powerhouse in French on 15,440 and 17,780 kHz. When France is on summer time, this shifts to 1100–1610.

Germany, East. R. Berlin International inserts 45 minutes of German between the 0100 and 0230 English on the generally inaudible 9730 kHz. On the same frequencies as the 0330 English, German follows at 0415.

Germany, West. Almost every night, Deutsche Welle jokes about its "enormous" 20-minute English program. For true enormity, try its 230-minute German program, aired twice at 2200 and 0200 on many hard-to-miss frequencies from Germany, Rwanda, Malta, Canada, Antigua and Montserrat. For this, DW publishes a day-by-day, hour-by-hour schedule similar to BBC's "London Calling." DW also provides morning news in German at 1300–1320 and 1330–1350.

Greece. On the same frequencies as English, Voice of Greece is in Greek at 0000–0015, 0045–0215, 0230–0350, 1200–1215, 1230–1250, 1500–1515, 1530–1550. And in French at 0030–0045.

Hungary. R. Budapest broadcasts more Hungarian to us than English, and on the same frequencies, at 0130–0200, 0230–0300, 0330–0400. On GMT Mondays this expands to 0130–0300 and 0330–0500.

Iran. Voice of Iran is slow to beam English our way, but there's plenty of music and Farsi after 2000 on 15,084

kHz. During the summer this is audible well into the night.

Israel. Each Israel Radio English program is accompanied by one in French on the same channels: 0515–0530, 1230–1300, 2030–2055, and 2200— 2230. Hebrew news follows English on same frequencies at 2300. The Hebrew home service is relayed our way on mostly weaker SW transmitters—at 0400–0610 on 7465 and 5882.5 kHz; 1740–2315 on 9355 and 12,077 kHz. At times, a channel above 15,500 kHz can also be heard.

Italy. English broadcast to Japan is longer than the one to North America! But Italian is something else: 2230–0100 on 11,905, 9710, 9630, 9575, and 6010 kHz. The variety of music and information on this service puts their leaden English ⅓ hour to shame. It's followed by French at 0120–0140.

Japan. R. Japan has a 15-minute Japanese newscast every hour of the day at 15 past (except for half-hours at 1030, 1430 and 2330) on same frequencies as English General Service, varying with season and time of day among 15,105, 9505, 5990 kHz. The 0130 English is preceded by Japanese at 0100, and is followed by Spanish at 0230–0300.

Korea, South. R. Korea, unlike R. Pyongyang, broadcasts more Korean than English our way. At 0230, 0430, 1600, and 2030 on 11,850 and 9640.

Libya. The People's Revolutionary Broadcasting is in Arabic only, most of the day on 15,100, 11,700, or 9500 kHz.

Netherlands. Both R. Nederland relays, in Madagascar and Bonaire, come in better here than in Holland itself. Daily Dutch from Bonaire for North America is at 0030–0120 on 6165 and 6020 kHz; 0430–0520 on 9590 and 6165 kHz. And on Sundays only at 2130–2220 from Holland on 9715 kHz; from Bonaire 2230–2320 on 15,320 and 15,180 kHz. Spanish: 0330–0420 on 9590 and 6165 kHz.

Norway. Check R. Norway's English schedule. The preceding hour on Sundays, and the entire 90 minutes on weekdays is in Norwegian, with some English music announcements.

Poland. R. Warsaw insists on not specifying what times are Polish and what are English to North America—but usually the Polish is at 0230–0300 and 0330–0400 on the same frequencies. Most of them are inaudible except at midsummer.

Portugal. Another country with more native language than English. Portuguese is at 0100–0300 and 0330–0500 on the same frequencies as English.

Romania. R. Bucharest until recently had Yiddish to North America. But now, on same channels as English, it's only Romanian at 2300–2400 and 0230–0300.

Spain. RTVE employs a different and larger frequency net for Spanish than for English. A two-hour service is aired thrice, at 2300, 0100, and 0300. Prime channels are 11,945, 11,775, 9630, 9360, and 6120 kHz. Also, for seamen in the "northwest Atlantic," from 2145.

Sweden. R. Sweden has Swedish at 2330, following English at 2300; at 0100 and 0200 on the same frequency as 0030 English; at 1430 on the same as 1400 English. French is at 0230 on a single frequency. Some of the Spanish broadcasts for "Latin America" are on the same beam as eastern North America: at 0000 and 0130, it is the same as 0030 English; and at 0300, it is the same as 0230 French. This Spanish crossing on the way to Central America holds true for many other European stations.

Switzerland. Each Swiss language gets exactly the same time as English, on the same frequencies in subsequent half hours: 0245 in German, 0315 in French, 0345 in Italian; 0500 in Italian, 0530 in German, 0600 in French; 1345 in German, 1415 in French, 1445 in Italian, and Spanish at 0215.

Taiwan. VOFC has standard Chinese at 2040–2140 on the same channels as 2140 English, and surrounding the 0100 English are standard Chinese at 0000 and Cantonese at 0200–0300, on mostly same channels.

Thailand. Has perpetually inaudible North American service in English at 0415–0515 around 11,905 kHz, and caps this with French to North America at 0520–0550.

USSR. R. Moscow's North American service in English is only the tip of the iceberg. There are several different Russian services. SW relays of the "Mayak" second-program home service can be heard throughout the day and evening. R. Rodina (Homeland) at 2330–0030 and 0200–0300. A distinct Golos Rodiny at 0130–0200. "Atlantika," for seamen in the Atlantic, at 1300–1400; Pacific Ocean Radio Station at 0700–0800 and 1930–2030. R. Kiev has Ukrainian at 2200–2300 and 0330–0400. R. Vilnius is in Lithuanian at 0100–0130. Most of Yerevan's nondaily transmission at 0300–0330 is in Armenian.

Vatican. Radio follows 0100 English with French at 0115–0130, conflicting in time with Rome's other shortwave station.

If you'd just like to hear broadcasts in a certain language, the Voice of America may be the answer. Reception is best in the central states. ◇

Computer Bits

by Leslie Solomon

HIGH-RESOLUTION GRAPHICS

NO MATTER how many alphanumeric characters your terminal can put on the screen, there are times when those characters are no substitute for graphics. However, when you examine the field, you will find that many low-cost "graphics" displays are simply nonalphanumeric characters resident within the character generator used, or they are limited to simple bar graphs. There are boards and systems that have some graphics capability, but the graphics are generally small "blocks" rather than discrete dots, so their overall effect is somewhat coarse.

Recently we had an opportunity to try out a new graphics board, the ALT-256*2 Graphic Display Interface ($395 assembled and tested) from Matrox Electronic Systems, POB 56, Ahuntsic Stn., Montreal, Canada H3L 3N5 (Tel: 514-481-6838), and available through most computer stores. This S-100 bus board can display 256 lines with 256 individually addressed dots on each line, thus allowing for excellent resolution. Each dot can be made black, white, or, if three boards are used, any color. The system can work with as many as eight boards but in this case, direct manipulation of the color byte is required as explained in the manual. Access time is 3.4-μs per dot, and the entire screen can be erased with a single instruction. The board can use external sync, and can be strapped for USA or European TV standards for noninterlaced display.

Graphics using the Matrox interface, shown at upper right.

The ALT-256*2 board contains 65k × 1 of RAM, and individual 8-bit registers for the X and Y coordinates and the data for each dot. Thus, it is easy to specify an individual dot anywhere on the screen, and determine whether that particular dot should be black or white (or color if you use extra boards). The screen can be erased black or white depending on the data sent to the input.

The software provided with the ALT-256*2 consists of a very detailed manual, and a pair of paper tapes. One tape contains the MTX GRAPH software that is configured as a series of callable subroutines while the second tape contains a demonstration program that uses the MTX GRAPH to create a continuous action graphics display. Total memory required is about 1k.

Six of the seven subroutines in the MTX GRAPH package are: INITG (initializes the system to standard defaults); PAGE (erases the entire screen); CURSOR (allows positioning the cursor at point X, Y); DOT (sets the point defined by the cursor); LINE (creates a line of dots between the current cursor position and the point X, Y); and CHAR (displays an ASCII character at the current cursor position). In the latter routine, the cursor is left at the next character position. Certain control characters are then used to select color, fixed or proportional character spacing, and dot size. The last routine is called ANIMAT, which produces a pause until the start of the next vertical blanking period, and is used in animation routines.

After plugging the ALT-256*2 into our S-100 computer, we loaded both tapes, and following the manual, started the demonstration program. Because we had only one board, and a monochrome monitor, we had no experience with color operation.

Comments on Use. The demonstration is impressive. It starts with a set of large characters on screen, followed by an interesting "lace curtain" effect that

INTERFACE AGE

The magazine that brings the computer home.

You want to learn all you can about personal computing. **Interface Age** tells it all. In simple, easy to understand language.

Each issue of **Interface Age** revolves around the latest information in the world of microcomputing. Articles, letters, new products, opinions, humor, experiments and new programs to help you choose and understand your computer and use it to full capacity.

Did you know your personal computer can–

- Help you start a business at home providing services to others.
- Increase your child's educational opportunity.
- Analyze real estate, stock market and other investments.
- Show you how to save money by computing and simplifying income tax & deduction records.
- Inventory your household items, store shopping lists and establish a recipe bank to plan daily meals.
- Control your small business with accounting and inventory control systems.

Technology has brought the computer to your world. **Interface Age** brings it home.

Order your subscription to **Interface Age** NOW with this convenient coupon. Save $7 over newsstand price. **12 Monthly Issues: $14 U.S.; $16 Canada/Mexico; $24 International. 24 Issues: $24 U.S.; $28 Canada/Mexico. 36 Issues: $36 U.S.; $42 Canada/Mexico.**

Name____________________

Address____________________

City__________ State______ Zip______

☐ Visa Card · ☐ Master Charge

Acct. No.______________ Exp. Date______

Signature____________________

Check or money order (U.S. Funds drawn on U.S. Bank)
Make checks payable to: **INTERFACE AGE MAGAZINE**
P.O. Box 1234 Dept. PE4 Cerritos, CA 90701
☐ *Please send information on issues available back to 1975.*

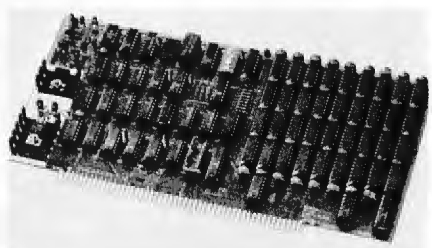
creeps across the screen. Suitable pauses are built-into the program so that you can study the various patterns on screen. Then follows a series of fan-like displays that illustrate line-calling routines, and some small (but very clear) alphanumerics. After a few more demonstrations of the various calling routines, a little man is made to "walk" across the screen, with swinging arms, to demonstrate the animation portion.

The manual contains a considerable amount of information and includes a complete listing of both the demonstration program and the MTX GRAPH package.

We have been playing with some 8080 machine language programs to "call" the various graphics subroutines and learn how best to use the high-resolution graphics. The results have been surprisingly good. We are also writing some BASIC programs using FILL and CALL commands to access the graphics software, also with successful results. One future project is a joystick interface for some really adventurous picture creations.

If high-resolution graphics appeals to you, drop into your local computer store and take a look at this new system from Matrox.

Z80 Things. North Star Computers, Inc., 2465 Fourth St., Berkeley, CA 94710 (Tel: 415-549-0858) has introduced a couple of Z80 goodies. The first is a 4-MHz Z80 board compatible with an S-100 bus, called the ZPB. It is available for $199 in kit form or $259 fully assembled. Features include auto-jump startup, vectored interrupts, operation with or without front panel, and space for 1k of 2708 EPROM. The EPROM option is $49 for the kit and $69 assembled.



The North Star 16k RAM board for use with 8080 or Z80.

The other Z80 device is a 16k RAM board (S-100) for use with either 8080 or Z80 and will operate at full speed (no wait states) at 4 MHz. The RAM's are 200 ns, and on-board refresh is provided. Bank switching capability is provided

and board addressing is switch-selectable in two 8k sections. An important feature is the availability of a parity check option. The 16k board is $399 in kit form, and $459 fully assembled. The parity option is $39 kit and $59 assembled.

PROMing. Oliver Audio Engineering, Inc., 676 West Wilson Ave., Glendale, CA 91203 (Tel: 213-240-0080), which brought us the first low-cost paper-tape reader, now introduces its PP-2708/16 PROM programmer ($249 as a kit, $295 assembled and tested). The new programmer plugs directly into any 2708 or TMS-2716 socket, and the PROM to be programmed is mounted in its zero-insertion-force socket. The data is dumped over the eight lower address lines using the OAE interface. No additional power supplies are required and all timing and control sequences are au-

The OAE PP-2708/16 PROM programmer plugs into any 2708 or TMS-2716 socket.

tomatically handled by the programmer. Because of this simplicity, only a short software routine is required. A five-foot flat ribbon cable interconnects the programmer with the PROM socket.

Bus Stop. If you have an Altair/S-100 bus system, or are planning to get one, there are a couple of new motherboards of which you should be aware. The first is from Vector Electronic Co., Inc., 12460 Gladstone Ave., Sylmar, CA 91342 (Tel: 213-365-9661). Their Model 8803 costing $29.95 accommodates 11 plug-in boards, and can have passive or active bus termination. One slot position may be used to interface the motherboard for system expansion. Twelve tantalum capacitors are included to suppress transients on the various power supply lines. Ground and +5-volt traces are rated at 10 amperes while the ±12-volt busses are rated at 7 amperes.

The second S-100 bus motherboard is from Thinker-Toys, 1201 10th St., Berkeley, CA 94710 (Tel: 415-527-7548) and costs $76. Called the Wunderbuss, this new motherboard features full shielding of the signal paths, and active termination of all data lines. Signal isolation is achieved by a cross-coupled system of ground lines interlaced between signal lines. The motherboard with 10 edge connectors is available for $120, and with 20 edge connectors the price is $154.

PROM/RAM Board. Now available from Vector Graphic, Inc., 790 Hampshire Road, Westlake Village, CA 91361 (Tel: 805-497-6853) is a new S-100 board that occupies two independently addressable 8k blocks, has 1k of RAM on board, and a capacity of up to 12k of 2708 EPROM's. Complete addressing flexibility is provided, and video or disk-operating system boards can be nested in the 3k of unused space. MWRITE logic and jump-on-reset allow operation without a front panel. A 24-command

Whatever you're looking for
you'll find it with a price/performance

Put Computer versatility and convenience in your home with the H8 Personal Computer System

Get into personal computing the right way with a powerful computer system from Heath. Start with the H8. It features 8-bit operation, fully expandable memory, a versatile 8080A CPU, and is the only machine in its price class that, due to its "intelligent" front panel and built in monitor program, can function without peripherals.

Next, add our 12" CRT video terminal. The H9 operates in three different modes, has a 67-key ASCII keyboard, and features a built in interfacing board to make hook-up a breeze.

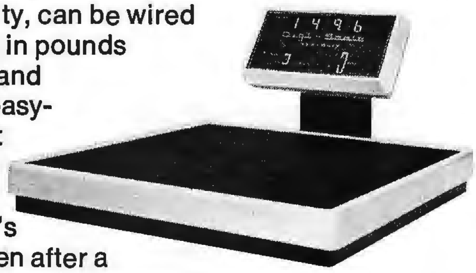
Add "mass storage" with the ECP-3801 cassette recorder/player and cassette I/O and you've got a system that's ready to go wherever your programming skills take you.

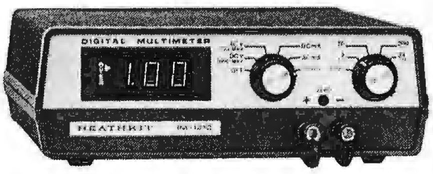
Our low-cost, effective Microprocessor Course teaches you all about Computers

Using our challenging self-instruction techniques and the optional ET-3400 Trainer, the EE-3401 Microprocessor Course takes you step-by-step through hardware, I/O interfacing, machine language programming, number systems, microprocessor operation, and much more. You'll complete experiments, gain hands-on experience and work directly with the devices that are "taking over" in today's electronics.

Weigh yourself with electronic precision with our Digital Electronic "Weighing Machine"

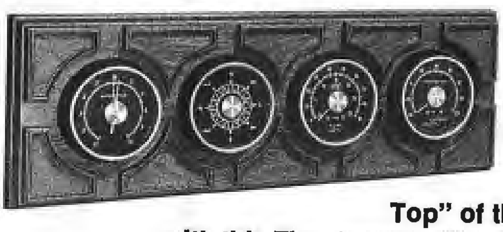
Uses solid-state electronics and a strain-gauge transducer element like expensive laboratory scales. The GD-1186 features 300-lb. capacity, can be wired to give weight in pounds or kilograms, and has a bright, easy-to-read 4-digit LED display. It's battery operated so it's safe to use even after a shower. And for extra convenience, the GD-1186 comes with additional cable so you can mount the read-out most anywhere you desire.





This Low-cost Multimeter gives you digital accuracy at analog prices

The IM-1210 is an economical performer that hobbyists and service techs have been waiting for. Capabilities include AC voltage measurement to 700 volts, DC to 1000 volts, current measurement, and 5-ranges for resistance checks. Accuracy is excellent and the bright digital display gives you readings at a glance.



Stay "On Top" of the Weather with this Five-function Weather Station

The ID-1290 Weather Station monitors indoor and outdoor temperatures, barometeric pressure, wind speed and direction — all with electronic accuracy and reliability. Ideal for home or office or anywhere accurate, instant weather information is needed.

PROM monitor is available to interface with most I/O boards. Price is $135 in kit form, $175 assembled.

Print an Apple. If you have an Apple II computer, then you should be aware that Microproducts, 1024 17th St, Hermosa Beach, CA 90265 (Tel: 213-374-1673), has introduced its PCB that interfaces the Apple II with the SWTP PR-40 Printer. The board, at $49.95 assembled, plugs into the Apple II and comes with an interconnecting cable. A cassette with operating software is also provided. The printer prints one line at a time when the return key is depressed. The printer subroutine can also be called in a BASIC program for usual printing.

A Microproducts board interfaces an Apple II with an SWTP PR-40.

New I/O Port. Since getting stuff into and out of a computer is somewhat of a necessity, and since most hobbyists now use more than one I/O device, multi-porting is becoming very important. Dajen Electronics, 7214 Springleaf Ct., Citrus Heights, CA 95610 (Tel: 916-723-1050) has one answer in their System Central Interface (SCI) board selling for $285 in kit form and $345 assembled and tested. This S-100 bus board provides a serial port with RS-232 and 20/60-mA current loops; baud rates from 45 to 9600; three independent 8-bit parallel ports that can be programmed bitwise for input and latched output; biphase (Tarbell) cassette port; onboard relays for control of two recorders; and three status lines to control an automatic tape deck. Also included are 256 bytes of RAM for stack and buffer storage; a 2708 programmer; space for three 2708's; and 2k system monitor program, having 18 commands. All IC's are socketed, and the board will work with 4-MHz Z80 systems. All output connectors, cable and plugs for recorder are provided.

1802 Items. Netronics, 333 Litchfield Rd., New Milford, CT 06776 (Tel: 203-354-9375), the source for the Elf-II, has announced a 4k RAM board for the Elf-II bus at $89.95 plus $3 postage/handling. Using 2102's and requiring 500-mA from the 5-volt line, the memory is buffered and decoded with page selection in 4k blocks anywhere in memory. There is an on-board regulator and three-state outputs. The board will preserve the 256 bytes of the original.

This same firm also has an Elf-II prototype board ($17 plus $1 postage/handling) that has room for 32 IC's in a mix of 14, 16, 20, 22, 24, or 40 pins. Wire-wrap or solder pencil connections can be used. Like the memory board, this board has gold-plated Elf-II bus connector fingers, and has provisions for a 5-volt regulator.

The third item announced by Netronics is an outboard Elf-II power supply that provides ±8 volts at 5 amperes, unregulated, and ±16 volts at 1 ampere, also unregulated. Price is $34.95 plus $3 for postage and handling. ◇

Software Sources

Basic Data Base Management System. People's Data Base System is a BASIC program for use in a variety of applications including word-processing, accounting, software development, mailing-list files and label-printing, schedules and lists, among others. The System will run on any BASIC with statements for DATA, DIM, GOSUB, GOTO, INPUT, LET, PRINT, READ, REM and string variable with MID$; this includes most 8k and some 5k BASICS. The system is available in book form, with complete source listing and applications printout, for $14.95. Write: Microware Div., Physical Biological Sciences Ltd., Box 47, Blacksburg, VA 24060.

8080 Software Contest. College and university students and faculty are eligible to enter a software contest announced by Intel's Insite program library. Entries must be written in Intel assembly language or PL/M and must include a source listing and test program to assure program validity, and a source paper tape or diskette. More than $28,000 worth of microcomputer development equipment, plus numerous $100 memberships in the Intel User's Library, will be awarded to colleges and universities submitting the best programs by June 30, 1978. Monthly winners will receive Intel PROMPT 48 or PROMPT 80/85 microcomputer design aid systems. The grand prize will be an Intellec 888 Microcomputer Development Center, including 64k RAM, dual-drive one-megabyte diskette system, CRT console, and software. Programs will be judged for their originality, documentation, creativity and applicability to microprocessors. Both individuals and teams may enter. For entry forms and details, write: Insite Library Contest, Intel Corp., Microcomputer Div., 3065 Bowers Ave., Santa Clara, CA 95051.

8080/Z80 Cassette Operating System. The ZAPS Cassette Operating System includes a Z80 assembler, text editor, in-memory file system, labelled cassette tape storage system and other utilities. Runs in 14k of memory, including buffers and 1k for symbol table, on most 8080 and Z80 systems. The assembler processes the Zilog mnemon-

ics, with a wide variety of pseudo-operands available. The system can accept numerical values in hex, octal, decimal or binary. A 90-page user manual includes I/O modification instructions. On Tarbell, Digital Group or TDL cassette, $60 from computer stores or write to Algorithmics, Box 56, Newton Upper Falls, MA 02164.

High-Level Language for 6502. FCL65E, a high-level language similar to DEC's FOCAL, is available for 6502-based microcomputer systems. The 6.5k program offers 8-to-9-digit accuracy, 8-level priority interrupt handling, string variables and functions. Commands include Ask, Comment, Continue, Do, Erase, For, Go, If, Modify, On, Quit, Return, Set, Type and Write, plus several commands called by symbols. The interpreter permits editing, corrections of current line, debugging and error detection, plus functions for absolute value, integer, integer rounding, random number, I/O device functions, ASCII/decimal and decimal/ASCII conversions, terminal echo suppression, memory examine and deposit, user subroutines, string comparisons, and others. FCL65E is available for TIM- and KIM-based systems. All system-specific I/O calls are located in a zero page block for easy modification to other 6502 systems. A complete listing is $35, a mini-manual is $6 and a 104-page user's manual is $12. Hex or binary paper tape or hex dump is available for $17. The program is also available on KIM cassettes in Hypertape (6X speed) format at $19. At regular speed, KIM cassettes are $23.50, and 3X-speed cassettes are $20.25. Write: The 6502 Program Exchange, 2910 Moana Ln., Reno, NV 89509.

6800 Text Editing & Processing Systems. The editing system is line- and content-oriented for easier assembly-language program development and document preparation. Edit directives include Append, Change, Copy, Move, Delete, Insert, Overlay, Print, and Replace—plus pointer-addressing and string searches. Other commands display output-format and up to 20 tab-stop settings, and display or suppress line numbers. Renumbering is also available, as are paper-tape or cassette save, write, read and gap (null string) commands. The Text Processing System, a companion program, is used to format edited files for printing or display. Options include paging, titling, page numbering, paragraphing, spacing and right-margin justification. The 6800 Text Editing System is $23.50; the Text Processing System (which can also be used independently) is $32, with both in complete manual form with source listing. KC-standard cassettes are $6.95 each, for either program. Write: Technical System Consultants, Inc., Box 2574, W. Lafayette, IN 47906.

PDP-8 Simulator for 8080. The Simul8tor permits 8080 computers to run PDP-8 programs, which are widely and inexpensively available. (However, speed limitations may preclude the use of such programs as PDP-8 BASIC and FOCAL, and the availability of DP-8 software on paper tape rather than cassette may be intolerable to some users.) Simul8tor is available on Intel-format paper tape or Tarbell cassette for $20. Write: The Amide Corp., Box 600, Sag Harbor, NY 11963.

6800 Disassembler. Available in punched paper tape (MIKBUG format) with assembly listing, object code and instructions, this program will print an assembly listing of the object code of any program stored in memory. It operates in less than 1.8k bytes, beginning at 0800 hex (2k decimal). $12.95. Write: Software Exchange, 2681 Peterboro, W. Bloomfield, MI 48033.

Popular Electronics

Reprint series

Many important articles covering a variety of interests in the broad field of electronics are published in POPULAR ELECTRONICS. Reprints of selected articles and test reports are now available in the event that you missed some you would like to have for reference or study purposes—or for projects you wish to build. Reprints in this series are only $1 each (*75¢ for those marked with an asterisk.) Minimum order is $2.

SPECIAL ARTICLES

AUDIO

1. How The New FTC Hi-Fi Rules Affect You
2. How To Evaluate Tape Recording Specs
3. A New Standard For FM Tuner Measurements

COMPUTER

7. How To Select A Microcomputer
8. Ins & Outs Of Computers For Beginners

COSMAC "ELF" SERIES (Reprint #'s 4, 5, 6, & 17)

4. Low Cost Experimenter's Microcomputer
5. Experimenter's Microcomputer/With Hardware Improvements & More Programming Details
6. Microcomputer/How To Expand Memory, Plus More Programs
17. Build The Pixie Graphic Display

CB RADIO

9. CB Specifications Made Easy
10. How To Choose CB Base Station Antennas

OTHER

14. How To Design Your Own Power Supplies
15. The Care & Feeding Of NiCd Batteries
16. Build A Gas & Fume Detector

LEARNING ELECTRONIC THEORY WITH CALCULATORS SERIES (Reprint #'s 11, 12, & 13)

11. Basic Equations and OHM's Law
12. Reactance, Time Constants And AC Calculations
13. RC Coupling, Basic Amplifier Calculations, and RLC Relationship

TEST REPORTS

AUDIO

18. ADC Accutrac 4000 Record Player
19. *Empire Model 698 Manual Turntable
20. Kenwood Model 600 Integrated Stereo Amplifier
21. *MXR Stereo Graphic Equalizer
22. *Nakamichi Model 500 Stereo Cassette Deck
23. Onkyo Model TX-4500 AM/Stereo FM Receiver
24. *Ortofon MC20 Moving Coil Phono Cartridge
25. *Pickering Model XV-15/625E Stereo Phono Cartridge
26. Pioneer Model CT-F8282 Stereo Cassette Deck
27. Radio Shack "Realistic" Model STA-2000 AM/Stereo FM Receiver
28. Rotel RX-7707 AM/Stereo FM Receiver
29. Sansui Model TU-9900 AM/Stereo FM Tuner
30. *Shure Model M24H Stereo Phono Cartridge
31. *Sony Model TA-4650 V-FET Stereo Power Amplifier
32. *Spectro Acoustics Model 210 Stereo Graphic Equalizer
33. *Stanton Model 681EEE Stereo Phono Cartridge
34. Teac Model PC-10 Portable Stereo Cassette Deck
35. *Technics Model SB-6000A Linear Phase Speaker System
36. *Thorens Model TD-126C Record Player

COMMUNICATIONS

37. *Cobra Model 29XLR 40-Ch. AM CB Mobile Transceiver
38. *Drake Model SSR-1 AM/SSB Communications Receiver
39. *Kenwood Model TS-820 Amateur Radio Transceiver
40. *Kris Model XL-50 40-Ch. AM CB Mobile Transceiver
41. *President Model "Washington" 40-Ch. AM/SSB CB Base Station
42. Yaesu Model FRG-7 AM/SSB Communications Receiver

TEST INSTRUMENTS

43. *B&K-Precision Model 280 Digital Multimeter
44. *B&K-Precision Model 1471B Dual-Trace Scope
45. *Ballantine Model 1010A Dual-Trace Scope
46. *Fluke Model 8020A Digital Multimeter
47. *Hewlett-Packard Model 280 Digital Multimeter
48. *Sencore Model DVM-32 Digital Multimeter
49. *Sencore Model TF-70 Portable Transistor Tester
50. *Triplet Model 60 Analog Multimeter

*REPRINTS MARKED WITH ASTERISK 75¢; ALL OTHERS $1.00. MINIMUM ORDER $2.00.

Popular Electronics Reprints, P.O. Box 278, Pratt Station, Brooklyn, New York 11205 E48

Please send the reprints listed below:

75¢ Each

Reprint #	Quan.	Reprint #	Quan.

$1.00 Each

Reprint #	Quan.	Reprint #	Quan.

Print Name__________

Address__________

City__________

State__________ Zip______

NUMBER OF REPRINTS ORDERED:

@ 75¢__________ @ $1.00__________

TOTAL ENCLOSED $__________ †

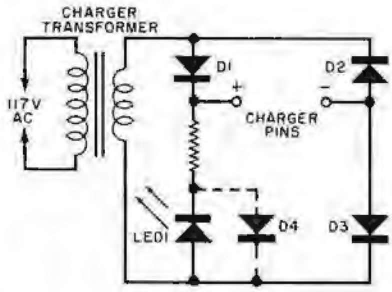
(MINIMUM ORDER $2.00)

†Residents of CA, CO, FL, IL, MI, MO, NY STATE, DC and TX add applicable sales tax. Outside U.S.A. add $1.00 per order.

Tips & Techniques

CHARGE INDICATOR

A LED indicator can be added to the charging stand for your rechargeable soldering iron to indicate whether or not the charging current is actually flowing. The circuit shown here will cause a negligible change in the normal charging current if your charger is a simple half-wave rectifier (as most are). This is especially important if you have a "quick charge" iron.



The LED will glow only when the iron is in the stand and making contact with the charger's output pins. Diodes *D1* through *D3* must be able to handle the maximum charging current. My "quick charge" iron draws about 440 mA maximum, so 1N4002's are suitable. A standard TIL-32 or similar LED can be used. Resistor *R1* is selected to limit LED current to a safe value. My charger has a 3-volt secondary, so I used a 330-ohm, ½-watt resistor.

When the iron is in its stand, diodes *D1* and *D3* allow full current to flow through the iron's batteries for one half of the ac cycle. During the other half cycle, only the low LED current flows through *LED1*, *R1*, the iron and *D2*.

Most chargers have enough room inside to accommodate the diodes and resistor. The LED should be mounted in a hole drilled in the charger housing so as to be plainly visible when the unit is operating. Also, take care to observe polarities when connecting the new components. Diode *D4* (same type as *D1* through *D3*) is needed only if the transformer's output voltage exceeds the reverse voltage rating of the LED.—*K.L. Kingston, Lafayette, IN.*

REMOVING ROSIN

While desoldering some DIP IC's, I discovered that removing the rosin from between the pins was very tedious. I tried cotton swabs, but the cotton came off the stick and left me with a bigger mess than I had started with. Happily, I discovered a solution. I took the discarded swab sticks and cut them at a 45° angle at one end. The point can be easily maneuvered between DIP pins, and the flat edge can be used for cleaning larger areas. As the end gets mangled, simply cut it off and start again. Toluene, available in most hardware stores, makes a good rosin solvent.—*Rebecca S. Peutz, Olympia, WA.*

RECONDITIONING NUT DRIVERS

The hex socket of an inexpensive, hand held nut driver can become worn with age, allowing slippage. But most are made with deep enough sockets to allow resurfacing. Grind down the socket past the rounded edges, but be careful not to remove so much metal that the socket becomes too shallow to accommodate the average hex nut.—*Joseph Smolski*

PANEL MOUNTING LED'S

Mounting LED's on a panel can be a problem. Although they can always be wedged into grommets, this tends to block off much of the light output. But there's another approach you can take when using the larger "dome" LED's with a shoulder molded around their bases (MV-5000 series and similar). Drop the leads through a pair of adjacent holes in a scrap of 0.1" (2.54-mm) perforated board. (Enlarge one hole slightly if necessary.) Drill out a hole on either side for mounting hardware. Then drill a hole in the panel to pass the dome but not the shoulder, and two holes for mounting hardware. Insert the LED and perf board from the rear and secure with No. 2 machine hardware. A fancier mount can be made from a discarded nylon banana jack. Remove the innards and cut off most of the bushing, leaving just enough thread to hold the nut firmly. Cement the LED in the top of the jack with leads passing through the body. If the leads are flexible, wedge a bit of cork or rubber into the bottom of the assembly to keep the leads from shorting. Don't forget to identify polarity *first!* Then mount the assembly onto the panel.—*Parke S. Barnard*

Electronics Library

IC OP-AMP COOKBOOK

by Walter G. Jung

Basic op amp theory is covered in this work, as well as practical circuit applications. Over 250 circuits are presented. The book is organized into three parts: an introduction to the IC op amp with discussion of general considerations; practical circuit applications; and two appendices of manufacturers' reference material. Circuits such as audio preamps, power amps, active filters, log amplifiers, function generators, and current-differencing amplifiers for general- (709, 741, and 101) and special-purpose IC's are included.

Published by Howard W. Sams & Co., 4300 W. 62nd St., Indianapolis, IN 46206. 592 pages. $12.95, soft cover.

TALK-BACK TV

by Richard Keith

In the not-too-distant future, viewers will be able to "talk back" to their TV receivers and get results. In fact, there are already a number of locations around the U.S. where cable TV is offering a host of talk-back services that range from electronic mail to meter reading. In anticipating the time when talk-back TV will be an everyday reality, this book discusses the history of the medium and details the possibilities it has to offer to the user. It reveals how talk-back TV is already providing a variety of services to the modern family and includes detailed descriptions of a number of currently operating systems. It also discusses the potential the new medium will have for intrusion on privacy.

Published by Tab Books, Blue Ridge Summit, PA 17214. 238 pages. $9.95 hard cover; $5.95 soft cover.

HANDBOOK OF OSCILLOSCOPE WAVEFORM ANALYSIS AND APPLICATIONS

by Miles Ritter-Sanders, Jr.

This new book introduces the reader to waveform development and the interpretation of waveform distortion. Linear and nonlinear circuit action are covered first, followed by solid-state circuit analysis and troubleshooting techniques. Later chapters discuss audio amplifier malfunctions and waveform analysis, stereo multiplex circuit tests, industrial electronics circuit action and waveforms, and basic magnetic-amplifier waveforms. Distinctions between ideal and real waveforms are illustrated, and the basic waveform-number relationships are explained without the use of higher mathematics.

Published by Reston Publishing Co., Inc., P.O. Box 547, Reston, VA 22090. Hard cover. 200 pages. $15.95

MICROPROCESSORS: FUNDAMENTALS & APPLICATIONS

Edited by Wen C. Lin

The purpose of this book is to aid readers who are weak in computer fundamentals to gain an understanding of how microprocessors work and how they are being applied in system design and instrumentation. The 42 reprinted papers that make up the contents of this book are arranged in four parts by subject category. The first part contains introductory papers on general microprocessor information. The second part covers architecture, software, interfacing, system development aids, and testing. Part three describes some of the myriad applications of microprocessors, while part four is concerned with microprogramming techniques as a bridge between hardware and software engineering. A glossary of computer terms is included.

Published by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. 335 pages. $17.95 hard cover; $9.95 soft cover.

SOLID STATE DESIGN FOR THE RADIO AMATEUR

by Doug DeMaw and Wes Hayward

Solid-state design theory and applications in r-f communications circuits are presented. Transistor and diode modeling, mixer and detector characteristics, r-f and i-f amplifiers, audio circuits, broadband amplifiers, power supplies and r-f matching circuits are illustrated and analyzed. There is an in-depth treatment of filter design and use, and detailed information on agc loops, receiver dynamic range, and test equipment. The book contains many previously unpublished practical circuits for power supplies, test equipment, r-f filters, transmitters, receivers and tranceivers. One chapter deals at length with portable operation.

Published by the American Radio Relay League, 225 Main Street, Newington, CT 06111. 256 pages (10¼" × 8¼"). $7.00, soft cover, in the USA and Possessions, $8.00 elsewhere.

ELECTRONMUSIC: A COMPREHENSIVE HANDBOOK

by Robert A. DeVoe

This is a how-to book that introduces the reader to the world of electronic music. No prior knowledge of electronic music is as-

(Continued on page 136)

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, *1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)*

Webster Chicago Model 80 wire recorder. Schematics and parts list, owners manual. Mike Carey, Box 361, Highway 20, Madison, AL 35758.

Jackson Condenser tester Model 650A. Operation manual and schematic. Nicholas Markovic, 2236 E. Euclid Ave., Milwaukee, WI 53207.

Gonset GSB 100. Manual and schematic. Kevin Grammes, 836 Boichot Rd., Lansing, MI 48906.

Acoustech I amplifier. Schematic. Edward Heyman, 300 Center Hill Rd., Centerville, DE 19807.

Superior Instruments Co., tube tester, Model TV-11. Operating instructions and schematic diagram. P.J. Hughes, 1337 Weber Dr., Clearwater, FL 33516.

Eico Model 460 oscilloscope. Schematic and parts source. Ron Aitken, 10840 Aintree Cres., Richmond, B.C. Canada V7A 3V1.

Rutherford Model B14 pulse generator. Operation manual and schematic. **Marconi** Instruments Ltd., Universal Bridge, operation manual and schematic. **Tektronix** type L plug-in unit. Operation manual and schematic diagram. D. Tovar, 4700 Rockmoor Ln., Fort Worth, TX 76116.

Knight amplifier Model T-175. Owner's manual and schematic. Bill Cross, 3561 Millburn Avenue, Baldwin, NY 11510.

Supreme Instruments Audolyzer Model 562. Schematic, operating manual. Richard Roggeveen, 5569 Dunsburry Ct., San Jose, CA 95123.

Motorola car radio Model 421, serial #11787-9W. Schematic. Anthony Bochichio, 45 Andrews St., Staten Island, NY 10305.

Fisher Model KX100 stereo master control amplifier. Schematic, parts list, service manual. William G. Agard, 881st Maint. Company, APO, NY 09165.

Bogen RPF60 FM stereo receiver. Instruction manual and schematic. Jesse Aronson, 755 Rugby Rd., Brooklyn, NY 11230.

Hallicrafters SX28 Super Skyraider. Schematic, operation manual, and related literature. William E. Pamplin, Box 527, Clarkston, GA 30021.

Heath GD-1999 Universal Color TV Game. Schematic and construction manual. John Francis, 3508 E. 22nd, Spokane, WA 99203.

Hammarlund Model HQ-180A receiver. Need schematic and service manual. Thomas G. Campbell, 246 E. Lincoln Ave., Altoona, PA 16601.

Hallicrafters SX110 receiver. R.T.T.A. signal generator Model K. Schematics and instruction manual. Walt Studer, 418 Walton Dr., Buffalo, NY 14225.

Jackson Model CRO-2 oscilloscope. Schematic and manual. R. Stanley, 129 N.W. 30th Street #7, Oklahoma City, OK 73118.

Texas Instruments Model SR-11 calculator. Schematic and pc layout. D. DiGiacomo, 713, George Ln., Glendora, NJ 08029.

Heathkit Vacuum Tube Voltmeter, Model V-4A. Schematic, operation manual, parts list. Howard E. Colbert, 810 South 21st St., St. Joseph, MO 64501.

Tektronix oscilloscope Model 315R. Schematic and alignment data. Lynn Russell, 4851 Aliana Plaza, Yorba Linda, CA 92686.

Truetone Model D711 radio receiver. Schematic. Maury Zivitz, 5136 Murphy Drive, Metairie, LA 70002.

Aiwa reel-to-reel tape recorder, model TP-710. Parts and schematic diagram. A.T. Most, 4 Lannigan Drive, Lawrenceville, NJ 08648.

(Continued on page 134)

Active Electronic Sales Corp.

Our New and Expanded Comprehensive 1978 Catalogue (144 pages) is finally available.

Please write for your complimentary copy.

Brand New 1978 IC Master

Complete integrated circuit data selector. New 1978 edition (2200 pages) is twice as big as last year. Master reference guide to the latest I.C.'s including microprocessors and consumer circuits. **$24.95**

Free quarterly updates.

Active Electronic Sales Corp.

P.O. BOX 1035 | FRAMINGHAM, MASSACHUSETTS 01701

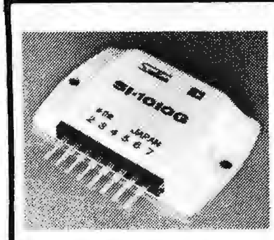
Over-the-counter sales,
12 Mercer Rd., Natick, Mass. 01760
Behind Zayres on Rte. 9
Telephone Orders & Enquires (617) 879-0077

IN CANADA 2 LOCATIONS

5651 Ferrier St.
Montreal, Quebec
Tel. (514) 735-6425

44 Fasken Dr.-Unit 25
Rexdale, Ontario
Tel. (416) 675-3311

MINIMUM ORDER $10.00 • ADD $2.00 TO COVER POSTAGE & HANDLING • Canadian customers add 30% for exchange and handling. All federal and provincial taxes extra.
Foreign customers please remit payment on an international bank draft or international postal money order in American dollars.



Sanken HYBRID AUDIO POWER AMPLIFIERS

SOCKET FOR SANKEN AUDIO AMPLIFIERS

FOR 10 & 20 W. A SI 9	$.95
FOR 30 & 50 W. A SI 10	$.95

- Multi-purpose linear amplifiers for comercial and industrial applicacations.
- Less than 0.5% harmonic distortion at full power level.
- 1/2 dB response from 20 to 100,000 Hz.
- Single or split (dual) power supply.
- Rugged, compact and lightweight packages.
- Built-in current limiting for SI-1050G and efficient heat radiating construction.

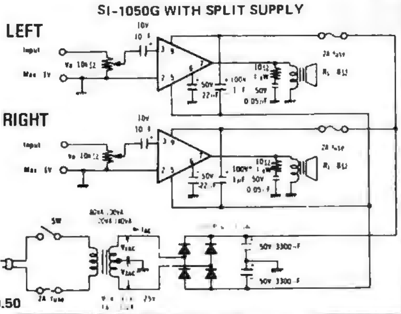
SANKEN Series SI-1000G amplifiers are self-contained power hybrid amplifiers designed for Hi-Fi, stereo, musical instruments, public address systems and other audio applications. The amplifiers have quasi-complementary class B output. The circuit employs flip-chip transistors with high reliability and passivated chip power transistors with excellent secondary breakdown strength. Built-in current limiting is provided for SI-1050G and all devices can be operated from a single or split power supply.

SI-1010G (10W output) . . . $ 6.90
SI-1020G (20W output) . . . $13.95
SI-1030G (30W output) . . . $19.00
SI-1050G (50W output) . . . $27.80

Data Sheet with Application Notes -- $0.50

TYPICAL CONNECTIONS

SI-1050G WITH SPLIT SUPPLY



EDGE CONNECTORS

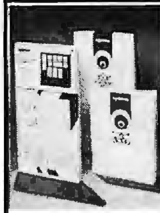
PINS	PART NUMBER	PRICE
.100 WIRE WRAP		
22/44	MP-0100-22-DW-5	$3.00
25/50	MP-0100-25-DW-5	3.30
36/72	MP-0100-36-DW-5	4.30
40/80	MP-0100-40-DW-5	4.70
50/100	MP-0100-50-DW-5	5.70
.125 WIRE WRAP		
22/44	MP-0125-22-DW-5	2.90
31/62	MP-0125-31-DW-5	3.90
36/72	MP-0125-36-DW-5	4.30
40/80	MP-0125-40-DW-5	4.70
50/100	MP-0125-50-DW-5	5.60
.156 WIRE WRAP		
15/30	MP-0156-15-DW-5	3.10
18/36	MP-0156-18-DW-5	3.40
22/44	MP-0156-22-DW-5	3.70
36/72	MP-0156-36-DW-5	4.90
43/86	MP-0156-43-DW-5	5.90
.156 SOLDER TAIL		
10/20	H411121-10	1.37
15/30	H411121-15	1.98
18/36	H411121-18	2.31
22/44	H411121-22	2.74
25/50	H411121-25	3.07
.156 SOLDER EYE		
10/20	H411131-10	1.37
15/30	H411131-15	1.98
18/36	H411131-18	2.31
22/44	H411131-22	2.74
25/50	H411131-25	3.07

MODEL 100 TEC-KIT

- Low-cost, conversational mode teletypewriter compatible CRT, displays 1920 characters in 80-character by 24-line format or optional 40-character by 24-line format for easy viewing
- Silent, stand-alone TEC KIT terminal is faster and simpler than TTY's
- Auto line feed on carriage return
- Operates at 15 switch selectable speeds from 50 to 9600 baud
- Choose from three standard interfaces -- RS-232 C, 20/60 MA current loop or TTL
- Detachable keyboard utilizes TTY format for easy operator adaption
- 23 standard switch selectable features directly accessible from rear of unit
- Upper/Lower case character set
- Switch selectable monitor mode allows display of control codes

Kit comes complete with clear cut, easy to follow instructions.

$795.00 Plus $8.00 for shipping and handling



1 ea	N3001 Microprogram Control Unit
4 ea	N3002 Central Processing Element
1 ea	74S182 Look Ahead Carry
3 ea	82S114 256 x 8 Prom
1 ea	BT31 Bidirectional I/O Port
2 ea	BT26A Quad Bus Transceiver
1 ea	Introductory Manual

ORDER PART NO 3000KT1000 $100.00

Ancrona Information #101 contains 236 pages of data, applications, and cross reference information.
FREE with purchase; regular $4.95
Bring or send this coupon with your next purchase and you will receive your copy free.

TV GAME CHIP & CRYSTAL

Features 6 selectable games -- tennis, soccer, squash, practice and two rifle shooting games. Full color, automatic scoring and much more, order AY-3-8500-1K for ship and crystal set $9.90
Order AY-3-8500-1 for chip only . . $8.90

50 VOLT CERAMIC DISC CAPACITORS

$1.00 Per Package

5pf 9/pkg	220pf 8/pkg	.001mfd 9/pkg	.015mfd 8/pkg
15pf 9/pkg	270pf 7/pkg	.0015mfd 9/pkg	.02mfd 8/pkg
25pf 9/pkg	300pf 7/pkg	.0022mfd 9/pkg	.022mfd 8/pkg
27pf 9/pkg	330pf 7/pkg	.003mfd 9/pkg	.03mfd 8/pkg
47pf 8/pkg	390pf 7/pkg	.0047mfd 9/pkg	.039mfd 7/pkg
68pf 8/pkg	470pf 7/pkg	.005mfd 9/pkg	.047mfd 7/pkg
100pf 8/pkg	560pf 7/pkg	.01mfd 9/pkg	.1mfd 6/pkg
150pf 8/pkg	680pf 7/pkg		

PLESSEY POLYESTER MINI-BOX CAPACITORS

$1.25 Per Package

MFD	QTY	MFD	QTY	MFD	QTY	MFD	QTY
.001	8/pkg	.0068	8/pkg	.039	7/pkg	.22	5/pkg
.0012	8/pkg	.0082	8/pkg	.047	7/pkg	.27	4/pkg
.0015	8/pkg	.01	8/pkg	.056	7/pkg	.33	4/pkg
.0018	8/pkg	.012	8/pkg	.068	7/pkg	.39	3/pkg
.0022	8/pkg	.015	7/pkg	.082	7/pkg	.47	3/pkg
.0027	8/pkg	.018	7/pkg	.1	7/pkg	.56	3/pkg
.0033	8/pkg	.022	7/pkg	.12	6/pkg	.68	2/pkg
.0039	8/pkg	.027	7/pkg	.15	6/pkg	.82	2/pkg
.0047	8/pkg	.033	7/pkg	.18	5/pkg	1.0	2/pkg
.0056	8/pkg						

CARBON FILM RESISTORS (5%)

Only in Multiples of 100 pcs per value (ohms)
¼W . . . $1.69 per 100
½W . . . $1.79 per 100

10	100	1.0K	10K	100K	1.0M
11	110	1 1K	11K	110K	1.1M
12	120	1.2K	12K	120K	1.2M
13	130	1.3K	13K	130K	1.3M
15	150	1 5K	15K	150K	1 5M
16	160	1.6K	16K	160K	1.6M
18	180	1 8K	18K	180K	1 8M
20	200	2.0K	20K	200K	2.0M
22	220	2 2K	22K	220K	2.2M
24	240	2.4K	24K	240K	2.4M
27	270	2 7K	27K	270K	2.7M
30	300	3 0K	30K	300K	3.0M
33	330	3 3K	33K	330K	3 3M
36	360	3 6K	36K	360K	3.6M
39	390	3 9K	39K	390K	3 9M
43	430	4 3K	43K	430K	4.3M
47	470	4.7K	47K	470K	4.7M
51	510	5 1K	51K	510K	5.1M
56	560	5 6K	56K	560K	5 6M
62	620	6 2K	62K	620K	6 2M
68	680	6 8K	68K	680K	6.8M
75	750	7 5K	75K	750K	7.5M
82	820	8 2K	82K	820K	8.2M
91	910	9 1K	91K	910K	10.0M

STANDARD MICROSYSTEMS

DATA COMMUNICATIONS CIRCUITS

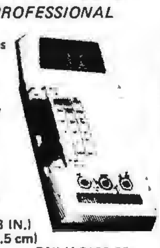
COM2017H	UART (High Speed)	$ 9.00
COM2017HP	UART (High Speed)	5.70
COM2017P	UART	5.70
COM2502H	UART (High Speed)	14.20
COM2502HP	UART (High Speed)	9.00
COM2502P	UART	8.00
COM2601	USRT	30.00
COM5016	Dual Baud Rate Gen.	13.20
CRT5027	CRT Controller	50.00

MICROPROCESSOR CRYSTALS

FREQ (MHz)	CASE	P/N	PRICE	FREQ (MHz)	CASE	P/N	PRICE	FREQ (MHz)	CASE	P/N	PRICE
1.00	HC33	CY1A	$9.50	4.9562	HC18	CY6A	$6.00	15.00	HC18	CY15A	$4.75
1.8432	HC33	CD1A	9.50	5.00	HC18	CY7A	6.00	18.00	HC18	CY19A	4.75
2.00	HC33	CY2A	8.25	5.068	HC18	CY5B	6.00	18.432	HC18	CY19B	4.75
2.4576	HC33	CY2B	8.25	5.7143	HC18	CB5C	6.00	19.6608	HC18	CY20A	4.75
3.2768	HC33	CY3B	6.00	6.00	HC18	CY6B	6.00	20.00	HC18	CY22A	5.25
3.579	HC33	CY3D	6.00	6.144	HC18	CY6C	6.00	23.684	HC18	CY23B	5.25
4.00	HC18	CY3A	6.00	8.00	HC18	CY8G	6.00	27.00	HC18	CY27A	8.15
4.434	HC18	CY4C	6.00	10.00	HC18	CY12A	4.75	32.00	HC18	CY32A	8.15
4.55	HC18	CY4B	6.00	14.31818	HC18	CY14A	4.75	100.00	HC18	CY100A	8.15

NEW from FLUKE MODEL 8020A

THE DMM FOR THE PROFESSIONAL



- 200-Hr. Battery Life
- 26 Ranges for 7 Functions
- 2000 Count Resolution
- High Low Power Ohms
- Autozero and Auto polarity
- MOV protected to 6000V against hidden transients and overload protection to 300V AC
- Diode Test Function
- Conductance Function checks leakage resistance to 10,000 mag ohms
- Size HWL (7.1 X 3.4 X 1.8 IN.) (18.0 X 8.6 X 4.5 cm)
- Weight 13 oz.

ONLY $169.00

NLS PORTABLE 15 MHz OSCILLOSCOPE

MS-15	MINISCOPE	$289.00
41-140	CARRYING CASE	30.00
41-141	10 TO 1 PROBE	24.50

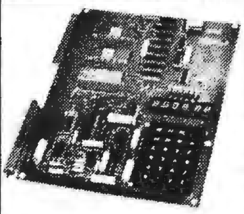
ALUMINUM ELECTROLYTIC (RADIAL LEAD)

Quantity per Package/ Price

MFD	10 volt	16 volt	25 volt	35 volt	50 volt
1	8/$1.00	7/$1.00	7/$1.00	7/$1.00	6/$1.00
4.7	7/$1.00	7/$1.00	6/$1.00	5/$1.00	4/$1.00
10	7/$1.00	7/$1.00	6/$1.00	5/$1.00	4/$1.00
22	7/$1.00	6/$1.00	5/$1.00	4/$1.00	4/$1.00
33	6/$1.00	6/$1.00	4/$1.00	4/$1.00	4/$1.00
47	6/$1.00	5/$1.00	4/$1.00	4/$1.00	3/$1.00
100	5/$1.00	5/$1.00	4/$1.00	4/$1.25	3/$1.00
220	4/$1.00	4/$1.00	3/$1.00	3/$1.25	2/$1.00
330	3/$1.00	3/$1.00	3/$1.25	2/$1.00	2/$1.00
470	3/$1.00	3/$1.25	2/$1.00	2/$1.25	$ .80
1000	--	--	2/$1.25	$ .80	$1.20
2200	--	--	$1.30	$1.60	$2.50

QUALITY PARTS

KIM-1 MICROCOMPUTOR



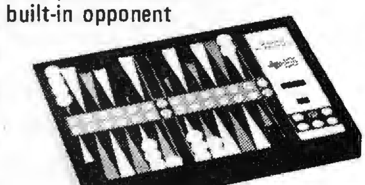
KIM-1--Computor Module from MOS Technology. 1K RAM, 2K ROM continuing system executive, complete audio cassett interface, 15 bidirectional I/O lines, a 24 key keyboard and a six-digit LED display.

Documentation--KIM-1 Users Manual 6500 Hardware Manual, and 6500 Programming Manual.

Fully Assembled Only
Fully Tested $245.00

COMPUTER BACKGAMMON

Now you can have a built-in opponent

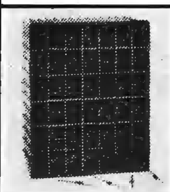


$200.00

CAPACITOR KITS in Compartmentalized Boxes

P/N	Description	Value	Qty	Price
TD1-S	Miniature Axial Lead Aluminum Electrolytic	1mfd to 470mfd 16vdc to 50vdc	25	$9.95
TD2-S	Miniature Axial Lead Aluminum Electrolytic	220mfd to 4700mfd 16vdc to 50vdc	10	$9.95
PD-S	Miniature Radial Lead Aluminum Electrolytic	1mfd to 1000mfd 16vdc to 50vdc	25	$9.95
DP-S	Radial Lead Epoxy Dipped Tantalum	1mfd to 100mfd 6.3vdc to 35vdc	20	$9.95
CD-S	Ceramic Disc	470pfd to 47000pfd 50vdc	150	$9.95
YM-S	Metalized Polyester Film	.0047mfd to 2.2mfd 250vdc	15	$9.95
PMG-S	Metalized Polyester Film	.0047mfd to 1.0mfd 250vdc	25	$9.95
EM-S	Polyester Film	.001mfd to .22mfd 100vdc	50	$9.95

HIGH QUALITY CARBON FILM RESISTOR KIT



COMPLETE WITH STORAGE BIN

Each KIT Contains 20 Each of 42 Different ¼ WATT 5% CARBON FILM RESISTORS

from 68 ohm to 4.7 megohm

$24.90

Intersil 3½ DIGIT PANEL METER

LCD or LED KITS

BUILD A WORKING DPM IN 1/2 HOUR WITH THESE COMPLETE EVALUATION KITS

Test these new parts for yourself with Intersil's low cost prototyping kits, complete with A/D converter and LCD display (for the 7106) or LED display (for the 7107). Kits provide all materials, including PC board, for a functioning panel meter.

ICL7106EV (LCD) $29.95 ICL7107 (LED) $24.95

ANCRONA

Send Check or Money Order to: P.O. Box 2208P, Culver City, Calif. 90230. Calif. residents add 6% sales tax. Minimum Order $10.00. ADD $1.00 to cover postage and handling. Master Charge and Bankamericard welcomed (include your card number and exp. date).
TELEPHONE ORDERS: Call (213) 641-4064

KX-33B MICROCOMPUTER

EASY-TO-USE 4-BIT MICROCOMPUTER

Easy to use 4-bit microcomputer intended to teach basic concepts of computer technology.

Perform control functions over 24 hour period using your instructions combined with input signals from any of the 3 transducers supplied with the unit.

Store any song that does not exceed its 3 octave range in memory and play it back through the built-in audio amp and speaker.

Also use the KX-33B for playing games, making various simulated sounds such as sirens, door bells and much more.

Completely assembled and ready to use -- operates on 110VAC, 60 Hz. $229.00

VISIT ONE OF OUR STORES TODAY

ANCRONA STORES DO NOT ACCEPT MAIL OR TELEPHONE ORDERS

CANADA, B.C. ANCRONA

CALIFORNIA ANCRONA 11080 Jefferson Blvd Culver City, CA 90230 (213) 390-3595	**CALIFORNIA ANCRONA** 1300 E Edinger Ave. Santa Ana, CA 92705 (714) 547-8424	**ARIZONA ANCRONA** 4518 E. Broadway Tucson, AZ 85711 (602) 881-2348
OREGON ANCRONA 1125 N.E. 82nd Ave Portland, OR 97220 (503) 254-5541	**GEORGIA ANCRONA** 3330 Piedmont Rd. NE Atlanta, GA 30305 (404) 261-7100	**TEXAS ANCRONA** 2649 Richmond Houston, TX 77098 (713) 529-3489

CIRCLE NO. 3 ON FREE INFORMATION CARD

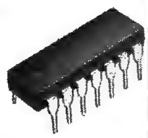
SHOP YOUR NEARBY RADIO SHACK FOR QUALITY PARTS AT LOW PRICES!

Top quality devices, fully functional, carefully inspected. Guaranteed to meet all specifications, both electrically and mechanically. All are made by well known American manufacturers, and all have to pass manufacturer's quality control procedures. These are not rejects, not fallouts, not seconds. In fact, there are none better on the market! Count on Radio Shack for the finest quality electronic parts.

TTL Digital ICs

First Quality

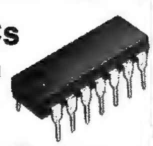
Made by National Semiconductor and Motorola



Type	Cat. No.	ONLY
7400	276-1801	35¢
7402	276-1811	39¢
7404	276-1802	35¢
7406	276-1821	49¢
7410	276-1807	39¢
7413	276-1815	79¢
7420	276-1809	39¢
7427	276-1823	49¢
7432	276-1824	49¢
7441	276-1804	99¢
7447	276-1805	99¢
7448	276-1816	99¢
7451	276-1825	39¢
7473	276-1803	49¢
7474	278-1818	49¢
7475	276-1806	79¢
7476	276-1813	59¢
7485	276-1826	1.19
7486	276-1827	49¢
7490	276-1808	79¢
7492	276-1819	69¢
74123	276-1817	99¢
74145	276-1828	1.19
74150	278-1829	1.39
74154	276-1834	1.29
74192	278-1831	1.19
74193	276-1820	1.19
74194	276-1832	1.19
74196	276-1833	1.29

CMOS ICs

100% guaranteed electronically and mechanically



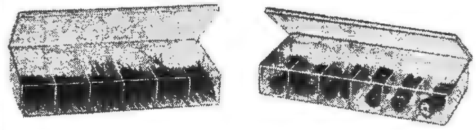
Type	Cat. No.	ONLY
74C00	276-2301	49¢
74C02	276-2302	49¢
74C04	276-2303	49¢
74C08	276-2305	49¢
74C74	276-2310	89¢
74C76	276-2312	89¢
74C90	276-2315	1.49
74C192	276-2321	1.69
74C193	276-2322	1.69
4001	276-2401	49¢
4011	276-2411	49¢
4013	276-2413	89¢
4017	276-2417	1.49
4020	276-2420	1.49
4027	276-2427	89¢
4049	276-2449	69¢
4050	276-2450	69¢
4511	276-2447	1.69
4518	276-2490	1.49

Linear ICs

By National Semiconductor and Motorola — first quality

Type	Cat. No.	ONLY
301CN	276-017	49¢
324N	276-1711	1.49
339N	276-1712	1.49
386CN	276-1731	99¢
555CN	276-1723	79¢
556CN	276-1726	1.39
566CN	276-1724	1.69
567CN	276-1721	1.99
723CN	276-1740	59¢
741CN	276-007	49¢
741H	276-010	49¢
3900N	276-1713	99¢
3909N	276-1705	99¢
3911N	276-1706	1.99
4558CN	276-038	79¢
75491	276-1701	99¢
75492	276-1702	99¢
7605	276-1770	1.29
7812	276-1771	1.29
7815	276-1772	1.29

Resistor and Capacitor Packs



Resistor and capacitor kits in handy plastic storage boxes you can use over and over again. Stock up!

½ Watt, 10% Tolerance Resistors. 271-601 .... **Pkg. of 350/9.95**
¼ Watt, 5% Tolerance Resistors. 271-602 .... **Pkg. of 350/9.95**
50WVDC Ceramic Disc Capacitors. 272-601 .... **Pkg. of 175/9.95**
35WVDC Radial Lead Capacitors. 272-602 .... **Pkg. of 35/9.95**
35WVDC Axial Lead Capacitors. 272-603 .... **Pkg. of 36/9.95**

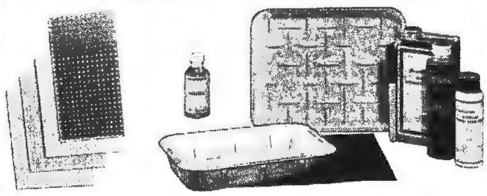
Tantalum Capacitors

Maximum capacity in smallest size. Low ESR, highly stable electrical characteristics and low leakage. Radial leads.

Cat. No.	μF	Each	Cat. No.	μF	Each
272-1401	0.1	39¢	272-1407	2.2	45¢
272-1402	0.22	39¢	272-1408	3.3	45¢
272-1403	0.33	39¢	272-1409	4.7	49¢
272-1404	0.47	39¢	272-1410	6.8	49¢
272-1405	0.68	39¢	272-1411	10.0	49¢
272-1406	1.0	39¢	....	...	...

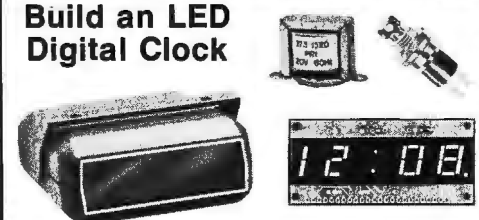
Nos. 1401-1408, 35WVDC; 1409-1411, 16WVDC.

PC Board Accessories



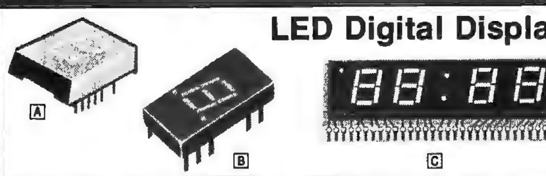
8-piece photographic PC board processing kit — fastest, easiest way to produce perfect printed circuit projects.
276-1560 .... **12.95**
Etch-Resist Marking Pen. 276-1530 .... **1.19**
Etchant Solution. 276-1535 .... **1.89**
PC Board Assortment. 276-1573 .... **1.98**

Build an LED Digital Clock



12-HR LED Clock Module. Just add a transformer and switches for a complete clock with 0.5" LED display. **277-1001** **14.95**
Transformer for above. 120VAC 60 Hz. **273-1520** **3.99**
SPST Miniature Pushbutton Switch. 275-1547 .... **5/1.99**
Display Case. 1¹³⁄₁₆x3⁷⁄₈x4⁷⁄₁₆". **270-285** **3.95**

LED Digital Displays



Digits	Size	Drive	Cat. No.	ONLY
A 1	0.6"	Anod.	276-056	2.99
A 1	0.6"	Cath.	276-066	2.99
B 1	0.3"	Anod.	276-053	1.99
B 1	0.3"	Cath.	276-062	1.99

Digits	Size	Drive	Cat. No.	ONLY
B 1	0.3"	Anod.	276-1210	4/6.99
B 1	0.3"	Cath.	276-1211	4/6.99
C 4	0.5"	Anod.	276-1201	6.95
C 4	0.5"	Cath.	276-1202	6.95

Power Supply Parts

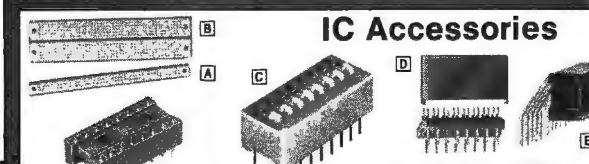
6-Amp Full-Wave Bridge Rectifier. 50 PIV.
276-1180 .... 1.99
50V 3-Amp Power Rectifier. 300-A surge.
276-1141 .... **Pkg. 2/69¢**

Electrolytic Capacitors

3300 μF at 35V. 272-1021 .... **2.99**
5000 μF at 35V. 272-1022 .... **3.49**
Heavy-Duty Transformers. All for 120VAC, 60 Hz.

Cat. No.	Volts	Current	Size	Each
273-1512	25.2 CT	2A	2¾x2¼x2"	4.99
273-1513	12	5A	4x2x2½"	8.95
273-1514	18 CT	4A	4x2x2½"	8.95

IC Accessories



A **Bus Strip. 276-173** **1.99**
B **Experimenter Socket. 276-172** **9.95**
C **DIP Switch. 275-1301** **1.99**
D **DIP Header. 276-1980** **1.29**
E **Right Angle 16-Pin Socket. 276-1985** ... **1.49**

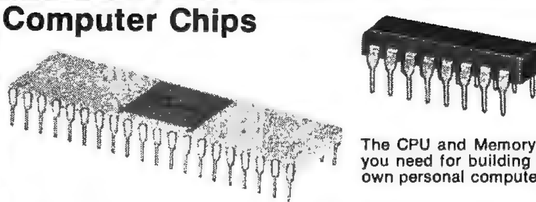
F Low-Profile DIP Sockets

Pins	Cat. No.	Price
8	276-1995	2/59¢
14	276-1999	2/89¢
16	276-1998	2/89¢
28	276-1997	Ea. 89¢
40	276-1996	Ea. 99¢

Silicon Solar Cells

Produce Power from Light!
2cmx4cm. 0.5V at 100mA. **276-120** **2.99**
2cmx2cm. 0.5V at 60mA. **276-128** **1.99**

Computer Chips



The CPU and Memory IC's you need for building your own personal computer.

8080A Microprocessor. An 8-bit National Semiconductor chip in a 40-pin DIP. *100% Prime.*
276-2510 .... **17.95**

2102 Static RAM. 1024-word by one bit read/write memory. Under 600 nS access time.
276-2501 .... **2.49 Ea. or 8/14.95**

Clock Chips

50252. 12-hour clock, 24-hour alarm chip. With full specifications. **276-1751** **6.99**
7001. 12-hour calendar alarm clock IC. With all data. **276-1756** **10.95**

WHY WAIT FOR MAIL ORDER DELIVERY? IN STOCK NOW AT OUR STORE NEAR YOU!

Radio Shack®

Prices may vary at individual stores and dealers

A TANDY COMPANY • FORT WORTH, TEXAS 76102
OVER 6000 LOCATIONS IN NINE COUNTRIES

DIGI-KEY CORPORATION

Quality Electronic Components

TOLL FREE 1-800-346-5144

MINNESOTA RESIDENTS 218-681-6674

DON'T FORGET OUR DISCOUNTS WHEN COMPARING PRICES

I.C.'S • RESISTORS • TRANSISTORS • CAPACITORS • DIODES • I.C. SOCKETS & PINS • SWITCHES
CLOCK MODULES • OPTOELECTRONICS • BREADBOARDING & TESTING DEVICES • DRAFTING SUPPLIES
DATA BOOKS • HEAT SINKS • WIRE • TOOLS... AND MORE... WRITE FOR FREE CATALOG........

INTEGRATED CIRCUITS

TTL

7400	.21	7440	.21	74100	1.28	74180	.70
7401	.21	7442	.53	74107	.30	74181	2.15
7402	.21	7443	.75	74109	.33	74182	.79
7403	.21	7444	.70	74116	1.26	74184	2.15
7404	.21	7446	.70	74121	.35	74185	2.15
7405	.21	7447	.70	74122	.44	74189	3.50
7406	.25	7448	.70	74123	.61	74190	1.23
7407	.25	7450	.21	74125	.40	74191	1.23
7408	.21	7451	.21	74126	.40	74192	.88
7409	.21	7453	.21	74128	.48	74193	.88
7410	.21	7454	.21	74132	.70	74194	.88
7411	.25	7460	.21	74141	.88	74195	.88
7412	.21	7470	.30	74145	.70	74196	.88
7413	.25	7472	.30	74147	1.63	74197	.88
7414	.69	7473	.30	74148	1.30	74198	1.49
7416	.25	7474	.30	74150	1.16	74199	1.49
7417	.25	7475	.48	74151	.70	74221	.86
7420	.21	7476	.32	74153	.65	74251	1.09
7421	.25	7480	.70	74154	1.03	74279	.55
7422	.25	7483	.70	74155	.70	74298	.94
7423	.35	7485	.89	74156	.70	74365	.67
7425	.35	7486	.28	74157	.70	74366	.67
7426	.25	7489	2.19	74160	.88	74367	.67
7427	.33	7490	.44	74161	.88	74368	.67
7428	.25	7491	.70	74162	.88		
7430	.21	7492	.44	74163	.88		
7432	.25	7493	.44	74164	.96		
7433	.30	7494	.70	74165	1.15		
7437	.25	7495	.70	74166	1.15		
7438	.25	7496	.70	74170	2.64		
7439	.50			74174	.98		
				74175	.93		
				74176	.79		
				74177	.79		

74LS00

74LS00	.28	74LS107	.39	74LS244	1.70
74LS01	.28	74LS109	.39	74LS247	.79
74LS02	.28	74LS112	.39	74LS248	.79
74LS03	.28	74LS113	.39	74LS249	.79
74LS04	.32	74LS114	.39	74LS251	.84
74LS05	.29	74LS122	.49	74LS253	.84
74LS08	.29	74LS123	.79	74LS257	.75
74LS09	.29	74LS125	.49	74LS258	.75
74LS10	.28	74LS126	.49	74LS260	.34
74LS11	.28	74LS132	.81	74LS261	2.00
74LS12	.28	74LS136	.39	74LS266	.39
74LS13	.47	74LS138	.79	74LS273	1.28
74LS14	1.02	74LS139	.79	74LS279	.62
74LS15	.28	74LS151	.75	74LS283	.79
74LS20	.28	74LS153	.75	74LS290	.65
74LS21	.28	74LS155	.75	74LS293	.65
74LS22	.28	74LS156	.75	74LS295	1.12
74LS26	.33	74LS157	.75	74LS298	1.03
74LS27	.33	74LS158	.75	74LS365	.67
74LS28	.33	74LS160	1.02	74LS366	.67
74LS30	.28	74LS161	1.02	74LS367	.67
74LS32	.33	74LS162	1.02	74LS368	.67
74LS33	.33	74LS163	1.02	74LS377	1.50
74LS37	.33	74LS164	1.02	74LS386	.39
74LS38	.33	74LS168	1.14	74LS395	1.74
74LS40	.28	74LS169	1.14	74LS670	2.34
74LS42	.70	74LS170	1.73	81LS95	.77
74LS47	.79	74LS173	1.34	81LS96	.77
74LS48	.77	74LS174	1.06	81LS97	.77
74LS51	.28	74LS175	.84	81LS98	.77
74LS54	.28	74LS181	2.50		
74LS55	.28	74LS190	1.18		
74LS73	.39	74LS191	1.18		
74LS74	.39	74LS192	.98		
74LS75	.53	74LS193	1.06		
74LS76	.39	74LS194	.88		
74LS78	.39	74LS195	.86		
74LS83	.79	74LS196	.86		
74LS85	.49	74LS197	.86		
74LS86	.39	74LS221	1.06		
74LS90	.57	74LS240	1.90		
74LS92	.57	74LS241	1.90		
74LS93	.57	74LS242	1.70		
74LS95	.88	74LS243	1.70		
74LS96	.88				

INTERFACE

8093	.40	75452	.61
8094	.40	75453	.61
8095	.67	75454	.61
8096	.67	75491	.81
8097	.67	75492	.84
8098	.67	75493	1.09
75450	.88	75494	1.19
75451	.61	MC1488N	.90
		MC1489N	.90

4000 CMOS

4000	.23	4022	.96	4060	1.58
4001	.23	4023	.23	4066	.79
4002	.23	4024	.84	4071	.23
4006	1.23	4025	.23	4072	.23
4007	.23	4026	1.83	4073	.23
4008	.79	4027	.40	4075	.23
4009	.44	4028	.89	4081	.23
4010	.44	4029	1.14	4082	.23
4011	.23	4030	.23	4502	.79
4012	.23	4033	1.51	4510	1.14
4013	.40	4034	3.08	4511	1.05
4015	.96	4035	1.14	4514	2.80
4016	.40	4040	1.14	4515	2.80
4017	1.05	4041	.79	4516	1.23
4018	1.05	4042	.79	4518	1.14
4019	.23	4043	.79	4520	1.14
4020	1.14	4044	.70	4527	1.68
4021	1.14	4046	1.86	4528	.88
		4047	.70	4585	1.23
		4049	.44		
		4050	.44		
		4051	1.26		
		4052	1.26		
		4053	1.26		

LINEAR

CA3046	.75	LM340T-6	1.25	NE558N	2.40
CA3086	.50	LM340T-8	1.25	NE559N	2.40
LF351N	.76	LM340T-10	1.25	NE560B	2.50
LF356N	1.20	LM340T-12	1.25	NE561B	2.50
LF357N	1.20	LM340T-15	1.25	NE562B	2.50
LF13741	.76	LM340T-18	1.25	NE565A	1.25
LM301AN	.44	LM340T-24	1.25	NE566V	1.25
LM307N	.64	LM341P-5	.98	NE567V	1.38
LM308N	1.00	LM341P-6	.98	UA709CV	.44
LM309K	1.80	LM341P-8	.98	UA710CA	.44
LM311N	.90	LM341P-10	.98	UA711CA	.53
LM317T	3.00	LM341P-12	.98	UA723CA	.60
LM317MP	1.90	LM341P-15	.98	UA733CA	1.25
LM318N	2.70	LM341P-18	.98	UA741CV	.44
LM320MP-5	1.30	LM341P-24	.98	UA747CA	.70
LM320MP-6	1.30	LM348N	1.60	UA748CV	.49
LM320MP-8	1.30	LM349N	1.60	UA7805CU	1.25
LM320MP-9	1.30	LM358N	.72	UA7806CU	1.25
LM320MP-12	1.30	LM1310N	1.84	UA7808CU	1.25
LM320MP-15	1.30	LM1800N	2.48	UA7812CU	1.25
LM320MP-18	1.30	LM1801N	1.70	UA7815CU	1.25
LM320MP-24	1.30	LM1812N	4.80	UA7818CU	1.25
LM323K	7.50	LM1830N	1.30	UA7824CU	1.25
LM324N	1.72	LM1889N	2.00	UA78L05ACZ	.40
LM325N	2.70	LM2111N	1.30	UA78L08ACZ	.40
LM326N	2.70	LM2907N	1.50	UA78L12ACZ	.40
LM327N	2.70	LM2917N	1.50	UA78L15ACZ	.40
LM339N	1.19	LM3089N	1.80	UA78L18ACZ	.40
LM340T-5	1.25	LM3900N	.88	UA78L24ACZ	.40
		LM3905N	1.40	UA7905CU	1.70
		LM3909N	.69	UA7906CU	1.70
		LM3911N	1.50	UA7908CU	1.70
		MC1456V	.50	UA7909CU	1.70
		MC1458V	.53	UA7912CU	1.70
		MC1496N	.70	UA7915CU	1.70
		MC3302P	.68	UA7918CU	1.70
		NE536T	2.50	UA7924CU	1.70
		NE540L	2.04		
		NE555V	.40		
		NE556A	.88		

MISC IC

MM5314N 3.75

NEW! 74C SUPER QUALITY SUPER PRICES

74C00

74C00N	.25	74C154N	2.90
74C02N	.25	74C157N	1.90
74C04N	.27	74C160N	1.18
74C08N	.25	74C161N	1.18
74C10N	.25	74C162N	1.18
74C14N	.90	74C163N	1.18
74C20N	.25	74C164N	1.10
74C30N	.25	74C165N	1.10
74C32N	.25	74C173N	1.30
74C42N	.96	74C174N	1.16
74C48N	1.28	74C175N	1.16
74C73N	.72	74C192N	1.38
74C74N	.48	74C193N	1.38
74C76N	.72	74C195N	1.10
74C83N	1.38	74C221N	1.90
74C85N	1.38	80C95N	.48
74C86N	.40	80C96N	.48
74C90N	.98	80C97N	.48
74C93N	.98	80C98N	.48
74C95N	1.10	74C901N	.48
74C107N	.70	74C902N	.48
74C150N	2.90	74C909N	1.78
74C151N	1.90	74C926N	7.80

STRANDED HOOK UP WIRE

20 ga PVC	2.50/100'	10.00/500'
22 ga PVC	2.80/100'	11.25/500'
24 ga PVC	2.10/100'	8.50/500'
26 ga PVC	2.10/100'	8.50/500'

Digi-Key Stocks the Entire AP Line

SILICON DIODES

1N4001	.64/10	5.50/C
1N4002*	.66/10	5.60/C
1N4003	.68/10	5.80/C
1N4004	.70/10	5.95/C
1N4005	.82/10	7.05/C
1N4006	.90/10	7.75/C
1N4007	.99/10	8.60/C
1N4148	.40/10	3.50/C

FREE CATALOG

SLIDE SWITCHES

SPST	.15	1.25/10	10.00/C
SPDT	.19	1.70/10	13.00/C
DPDT	.23	2.00/10	19.00/C

50 VOLT DISCS

100 PF	.40/10	3.50/C
220 PF	.40/10	3.50/C
470 PF	.40/10	3.50/C
.001 UF	.40/10	3.50/C
.0022 UF	.40/10	3.50/C
.0047 UF	.40/10	3.50/C
.01 UF	.45/10	3.65/C
.022 UF	.50/10	4.00/C
.047 UF	.70/10	5.60/C
.1 UF	1.35/10	11.50/C

MICROPROCESSORS

8080A	8-BIT CPU, 2 USEC CYCLE	$9.95
8212	8-BIT I/O PORT	$3.25
8216	BI-DIRECTIONAL BUS DRIVER	$3.25
8224	CLOCK GENERATOR	$3.25
8228	SYSTEM CONTROLLER	$6.00
8251	COMMUNICATIONS INTERFACE	$10.50
8255	PERIPHERAL INTERFACE	$10.50
1702A	2K EPROM 1 USEC	$5.75
2708	8K EPROM 450 NSEC	$15.75
2102AN-4L	1K LOW POWER 450 NSEC RAM	$1.69
SC/MP	8 VOLT SC/MP CPU	$9.95
2650	MICROPROCESSOR 1.25 MH-Z CLOCK 40 DIL	$24.95

I.C. SOCKETS

8 PIN SOLDER	.17	1.60/10	14.50/C
14 PIN SOLDER	.20	1.90/10	17.00/C
16 PIN SOLDER	.22	2.10/10	18.75/C
18 PIN SOLDER	.29	2.75/10	24.50/C
20 PIN SOLDER	.30	2.85/10	25.25/C
22 PIN SOLDER	.33	3.15/10	27.75/C
24 PIN SOLDER	.38	3.60/10	32.25/C
28 PIN SOLDER	.45	4.25/10	38.25/C
40 PIN SOLDER	.63	6.00/10	53.50/C
8 PIN W-W	.24	2.30/10	20.50/C
14 PIN W-W	.26	2.50/10	22.00/C
16 PIN W-W	.30	2.85/10	25.50/C
18 PIN W-W	.60	5.70/10	51.00/C
20 PIN W-W	.70	6.65/10	59.50/C
22 PIN W-W	.84	8.00/10	71.50/C
24 PIN W-W	.96	9.10/10	81.50/C
28 PIN W-W	1.12	10.60/10	95.20/C
40 PIN W-W	1.36	12.50/10	115.00/C

8080A CHIP SET

ONE EACH 8080A, 8212, 8224 and 8228 PLUS SIXTEEN 2102AN-4L ALL FOR — **$44.95**

MOLEX I.C. SOCKET PINS

.85/C 8.20/M 38.20/5M 275.00/50M

PLESSEY SAMPLER

AN ASSORTMENT OF METALIZED POLYESTER CAPACITORS
300 CAPS 18 VALUES $26.00

MINIBOX METALIZED POLYESTER CAPACITORS

.001	.14	1.15/10	9.00/C	.033	.15	1.25/10	10.00/C
.0022	.14	1.15/10	9.00/C	.047	.15	1.25/10	10.00/C
.0033	.14	1.15/10	9.00/C	.068	.15	1.25/10	10.00/C
.0047	.14	1.15/10	9.00/C	.1	.17	1.35/10	11.00/C
.0068	.14	1.15/10	9.00/C	.22	.23	1.85/10	15.00/C
.01	.14	1.15/10	9.00/C	.33	.30	2.50/10	20.00/C
.022	.15	1.25/10	10.00/C	.47	.36	3.00/10	24.00/C

ELECTROLYTIC CAPACITORS

VALUE	RADIAL LEADS			AXIAL LEADS		
.47/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
1/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
2.2/50V	.08	.65/10	5.41/C	.12	.90/10	7.82/C
3.3/50V	.08	.65/10	5.41/C	.12	1.00/10	8.31/C
4.7/35V	.08	.65/10	5.41/C	.11	.95/10	7.91/C
4.7/50V	.08	.68/10	5.75/C	.12	1.00/10	8.31/C
10/16V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
10/25V	.08	.65/10	5.66/C	.12	1.00/10	8.31/C
10/35V	.09	.70/10	6.12/C	.13	1.10/10	8.94/C
10/50V	.10	.75/10	6.58/C	.14	1.15/10	9.56/C
22/16V	.08	.67/10	5.66/C	.12	1.00/10	8.31/C
22/25V	.09	.70/10	6.09/C	.13	1.05/10	8.74/C
22/35V	.11	.85/10	7.29/C	.15	1.19/10	9.98/C
22/50V	.13	1.05/10	8.48/C	.17	1.32/10	11.22/C
33/16V	.09	.75/10	6.90/C	.12	1.00/10	8.48/C
33/25V	.10	.81/10	7.50/C	.14	1.15/10	9.56/C
33/35V	.13	1.05/10	9.65/C	.17	1.33/10	11.23/C
33/50V	.14	1.13/10	10.41/C	.19	1.52/10	12.89/C
47/10V	.09	.71/10	6.52/C	.13	1.04/10	9.50/C
47/16V	.10	.81/10	7.47/C	.14	1.15/10	9.56/C
47/25V	.13	1.05/10	9.65/C	.17	1.30/10	11.22/C
47/35V	.14	1.13/10	10.41/C	.19	1.51/10	12.89/C
47/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
100/10V	.10	.77/10	6.58/C	.14	1.13/10	9.56/C
100/16V	.11	.85/10	7.28/C	.17	1.30/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.30/C
100/35V	.15	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.30/10	19.70/C
220/10V	.13	1.08/10	9.15/C	.18	1.42/10	12.05/C
220/16V	.15	1.16/10	9.86/C	.20	1.55/10	13.30/C
220/25V	.17	1.21/10	14.55/C	.29	2.35/10	19.96/C
220/35V	.25	2.03/10	17.56/C	.32	2.79/10	23.90/C
220/50V	.29	2.35/10	19.96/C	.40	3.23/10	27.44/C
330/6V	.14	1.12/10	9.50/C	.19	1.48/10	13.71/C
330/10V	.15	1.16/10	9.83/C	.21	1.64/10	15.13/C
330/16V	.17	1.36/10	11.18/C	.31	2.45/10	22.70/C
330/25V	.23	1.86/10	15.79/C	.38	3.07/10	28.38/C
330/35V	.33	2.66/10	24.59/C	.43	3.43/10	31.68/C
330/50V	.54	4.30/10	39.73/C	.60	4.81/10	44.45/C
470/6V	.15	1.16/10	11.16/C	.20	1.64/10	15.13/C
470/10V	.21	1.71/10	14.55/C	.31	2.45/10	22.70/C
470/16V	.23	1.81/10	15.39/C	.33	2.66/10	24.59/C
470/25V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
470/35V	.41	3.27/10	30.26/C	.47	3.78/10	34.99/C
470/50V	.54	4.30/10	39.73/C	.75	6.03/10	55.80/C
1000/6V	.22	1.90/10	16.50/C	.35	2.76/10	25.54/C
1000/10V	.24	1.96/10	16.62/C	.38	3.07/100	28.38/C
1000/16V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
1000/25V	.42	3.33/10	28.27/C	.68	5.42/10	50.13/C
1000/35V	.60	4.81/10	44.45/C	.75	6.03/10	55.81/C
2200/6V	.36	2.86/10	26.48/C	.43	3.43/10	31.68/C
2200/10V	.42	3.33/10	28.27/C	.60	4.81/10	44.45/C
2200/16V	.54	4.30/10	36.58/C	.68	5.42/10	50.13/C

LED DIGITS AND LAMPS

FND357	.375" Single Digit, CC, Red	$1.35
FND500	.5" Single Digit, CC, Red	1.35
FND507	.5" Single Digit, CA, Red	1.35
FND800	.8" Single Digit, CC, Red	2.50
FND807	.8" Single Digit, CA, Red	2.50
NSN373	.3" Dual Digits, CA, Red	2.20
NSN374	.3" Dual Digits, CC, Red	2.20
NSN583	.5" Dual Digits, CA, Red	2.60
NSN584	.5" Dual Digits, CC, Red	2.60
NSN783	.7" Dual Digits, CA, Red	3.00
NSN784	.7" Dual Digits, CC, Red	3.00
NSL5053	Dif. Red T-1¾ Lamp w/Mtg. Hdwe	$1.80/10 $16.00/100
NSL5056	Dif. Narrow Angle Red T-1¾ Lamp w/Mtg. Hdwe	$1.80/10 $16.00/100

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS125	Set of 1 each of the 73 standard 5% ¼ watt carbon film resistors in the series ...	$9.90
RS225	Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors ...	$9.90

½ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS150	Set of 1 each of the 73 standard 5% ½ watt carbon film resistors ...	$9.90
RS250	Set of 5 each of the 73 standard 5% ½ watt carbon film resistors ...	$9.90

Bishop Graphics

The Digi-Key Catalog features many more quality Bishop Graphics products.

3365-ND 12.50

CLOCK MODULES

The MA1002 and MA1010 series clock modules by National Semiconductor are fully assembled and tested clocks using a 4 digit LED display and one MOS integrated circuit on the same board. Simply connect switches and our special transformer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green fluorescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

MA1002A	.5" LED 12 Hour AM-PM Clock Module	$10.50
MA1002A SET	Module with Transformer & Switches	$13.95
MA1002C	.5" LED 24 Hour Clock Module	$10.50
MA1002C SET	Module w/Transformer & Switches	$13.95
MA1003	12 Volt Car Clock with Switches	$17.50
MA1010A	.84" LED 12 Hour AM-PM Clock Module	$13.00
MA1010A SET	Module w/Transformer & Switches	$16.45
MA1010C	.84" LED 24 Hour Clock Module	$13.00
MA1010C SET	Module w/Transformer & Switches	$16.45

MA1002 0.5" High Digits

Actual Size: 1.375"x3.05"

MA1010 0.84" High Digits

Actual Size: 1.75"x3.75"

MA1003 $17.50 NEW!

DATA BOOKS

TTL DATA BOOK, 592 P, NAT. SEMI.	9010B	$4.00
LINEAR DATA BK, 952 P, NAT. SEMI.	9011B	$4.00
CMOS DATA BK, 77 EDIT, 555 P, NAT. SEMI.	9012B	$3.00
POWER TRANSISTORS, 151 P, NAT. SEMI.	9013B	$3.00
MEMORY DATA BK, 592 P, NAT. SEMI.	9014B	$3.00
MOS/LSI DATA BK 713 P, NAT. SEMI.	9015B	$4.00
INTERFACE DATA BK, 464 P, NAT.	9016B	$4.00
VOLTAGE REG. BK, 128 P, NAT. SEMI.	9017B	$3.00
LIN. APPLIC. BK, VOL. 1, 432 P, NAT. SEMI.	9018B	$4.00
LIN. APPLIC. BK, VOL. 2, 246 P, NAT. SEMI.	9019B	$4.00
AUDIO HANDBOOK, 196 P, NAT. SEMI.	9020B	$4.00
8080A MICRO. SYS. DESIGN MAN, NAT. SEMI.	9021B	$5.00
SC/MP MICRO. APP. HANDBK, NAT. SEMI.	9022B	$5.00
SPECIAL FUNCTION DATA BK, NAT. SEMI.	9023B	$3.00
CMOS I.C.'S, 278 P, SOLID STATE SCIENT.	9030B	$3.00
SIGNETICS ANALOG MANUAL, 637 P	9031B	$5.95

MICROPROCESSOR BOOKS ADAM OSBORNE

(NON-DISCOUNTABLE)

AN INTRODUCTION TO MICROCOMPUTERS, VOL I BASIC CONCEPTS	9000B-ND	$7.50
AN INTRODUCTION TO MICROCOMPUTERS, VOL II SOME REAL PRODUCTS	9001B-ND	$15.00
8080 PROGRAMMING FOR LOGIC DESIGN	9002B-ND	$7.50
6800 PROGRAMMING FOR LOGIC DESIGN	9003B-ND	$7.50

SAMS BOOKS

(NON-DISCOUNTABLE)

CMOS COOKBOOK	21398-ND	$9.45
THE BIG CMOS WALLCHART	21399-ND	$2.80
FET CIRCUITS	21439-ND	$4.70
IC TIMER COOKBOOK	21416-ND	$9.42
PRINCIPLES & APPLIC. OF INVERT. & CONV.	21454-ND	$7.55
ABC'S OF INTEGRATED CIRCUITS	20823-ND	$3.33
ABC'S OF RESISTANCE & RESISTORS	21126-ND	$3.75
ABC'S OF VOLTAGE-DEPENDENT RESISTORS	20771-ND	$3.09
ACTIVE-FILTER COOKBOOK	21168-ND	$14.20
COLLECTED BASIC CIRCUITS	20784-ND	$5.23
HOW TO DESIGN & USE MULTIVIBRATORS	21043-ND	$3.75
HOW TO USE IC LOGIC ELEMENTS	21081-ND	$4.70
IC OP-AMP COOKBOOK	20969-ND	$12.30
LED CIRCUITS AND PROJECTS	21006-ND	$4.99
MOS DIGITAL IC'S	21299-ND	$6.18
PRACTICAL SOLID-STATE CIRCUIT DESIGN	21018-ND	$6.18
RC CIRCUITS	21332-ND	$4.70
REGULATED POWER SUPPLIES	20844-ND	$5.23
RTL COOKBOOK	20715-ND	$5.46
TRANSISTOR SPECIFICATIONS MAN. (8TH ED.)	21335-ND	$6.60
TRANSISTOR SUBSITUTION HDBK (16TH ED.)	21333-ND	$4.70
ABC'S OF TRANSISTORS (3RD ED.)	21146-ND	$4.04
ABC'S OF ZENER DIODES	21045-ND	$3.75
FET PRINCIPLES, EXPER., & PROJECTS (2ND)	21167-ND	$8.08
LINEAR IC PRINC., EXPER., & PROJECTS	21019-ND	$8.50
MICROMINIATURE ELECTRONICS	20582-ND	$5.46
SEMICONDUCTOR REPLACEMENT GUIDE	21092-ND	$3.75
TRANSISTOR FUNDAMENTALS — A CAREFULLY PLANNED PROGRAMMED COURSE IN SEMICONDUCTOR THEORY AND CIRCUITRY.		
VOL. 1—BASIC SEMICOND. & CIRC. PRINC.	20641-ND	$4.99
VOL. 2—BASIC TRANSISTOR CIRCUITS	20642-ND	$4.99
VOL. 3—ELECTRONIC EQUIP. CIRCUITS	20643-ND	$4.99
VOL. 4—DIGITAL & SPECIAL CIRCUITS	20644-ND	$4.99
4 VOLUME SET	20645-ND	$18.53
TRANSISTOR-TRANSISTOR LOGIC	20967-ND	$6.17
TUBE SUBSTITUTION HDBK (19TH EDIT.)	21225-ND	$2.14
SPECIAL TWIN-PAK TUBE SUB. PACKAGE	21407-ND	$3.56
SOLID-STATE COMPONENTS	21099-ND	$3.75
SOLID-STATE IGNITION SYSTEMS	21049-ND	$4.70
SOLID-STATE POWER SUPPLIES & CONV.	20310-ND	$3.33
TRANSISTOR AUDIO AMPLIFIERS	20838-ND	$5.62
TTL COOKBOOK	21035-ND	$8.50
USER'S GUIDE TO TTL	21080-ND	$2.38
TV TYPEWRITER COOKBOOK	21313-ND	$9.45
UNDERSTANDING CMOS I.C.'S	21129-ND	$4.70
UNDERSTANDING OSCILLATORS	20837-ND	$4.70
UNIQUE IC OP-AMP APPLICATIONS	21163-ND	$4.70
HOW TO BUY & USE MINI & MICROCOMPUTERS	21351-ND	$9.45
HOW TO PROGRAM MICROCOMPUTERS	21459-ND	$8.50
MICROCOMPUTER PRIMER	21404-ND	$7.55
THE 8080A BUGBOOK: MICROCOMPUTER INTERFACING & PROGRAMMING	21447-ND	$9.45
COMPUTER DICTIONARY (2ND EDIT.)	20943-ND	$8.50
COMPUTER DICT. & HANDBOOK (2ND EDIT.)	20850-ND	$18.53
COMPUTERS & PROGRAMMING GUIDE FOR ENGIN.	20950-ND	$12.30
ABC'S OF CAPACITORS (3RD EDIT.)	20498-ND	$4.71

Digi-Key Means Quality, Service & Savings

½ WATT ZENER DIODES

.15 1.30/10 11.00/C

1N5226B	3.3V	1N5242B	12V
1N5227B	3.6V	1N5243B	13V
1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
1N5240B	10V	1N5256B	30V
1N5241B	11V	1N5257B	33V

HARDWARE

2-56 1/4 SCREW	.99/C
2-56 1/2 SCREW	.99/C
4-40 1/4 SCREW	.65/C
4-40 1/2 SCREW	.60/C
6-32 1/4 SCREW	.65/C
6-32 1/2 SCREW	.75/C
8-32 3/8 SCREW	.90/C
8-32 5/8 SCREW	.99/C
2-56 HEX NUT	.55/C
4-40 HEX NUT	.55/C
6-32 HEX NUT	.60/C
8-32 HEX NUT	.60/C
NO 2 LOCKWASHER	.85/C
NO 4 LOCKWASHER	.45/C
NO 6 LOCKWASHER	.45/C
NO 8 LOCKWASHER	.45/C

FREE CATALOG

SILICON TRANSISTORS

MPS918	.16	1.55/10	13.60/C	130.00/M
MPS930	.16	1.55/10	13.60/C	130.00/M
MPS2222A	.16	1.55/10	13.60/C	130.00/M
MPS2369A	.16	1.55/10	13.60/C	130.00/M
MPS2907A	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3640	.16	1.55/10	13.60/C	130.00/M
MPS3641	.16	1.55/10	13.60/C	130.00/M
MPS3643	.16	1.55/10	13.60/C	130.00/M
2N3904	.16	1.55/10	13.60/C	130.00/M
2N3906	.16	1.55/10	13.60/C	130.00/M
2N4124	.16	1.55/10	13.60/C	130.00/M
2N4126	.16	1.55/10	13.60/C	130.00/M
2N4401	.16	1.55/10	13.60/C	130.00/M
2N4403	.16	1.55/10	13.60/C	130.00/M
2N4410	.16	1.55/10	13.60/C	130.00/M
2N5087	.16	1.55/10	13.60/C	130.00/M
2N5089	.16	1.55/10	13.60/C	130.00/M
2N5210	.16	1.55/10	13.60/C	130.00/M
2N3055	.99	9.20/10	85.00/C	800.00/M
MPF102	.36	3.35/10	30.60/C	300.00/M
2N5457	.48	4.50/10	41.00/C	400.00/M
MPSA13	.28	2.60/10	24.00/C	230.00/M
MJ2955	.99	9.20/10	85.00/C	800.00/M

DOUBLE DIGIT DISCOUNTS SAVE YOU EVEN MORE!

HANDLING CHARGES

$ 0.00-$ 4.99	Add $2.00
$ 5.00-$24.99	Add $0.75
$ 25.00-$49.99	Add $0.50
$ 50.00-$99.99	Add $0.25
$100.00 & Up	No Charge

VOLUME DISCOUNT & HANDLING CHARGE

All items except those with catalog numbers ending with the suffix-ND may be combined for discount. First—total all discountable items and apply the volume discount. Then add to this sub-total the nondiscountable items. Add the handling charge. This is your total cost. We pay all shipping and insurance to addresses in the U.S.A. and Canada.

VOLUME DISCOUNT

$ 0.00-$ 24.99	NET
$ 25.00-$ 99.99	Less 10%
$ 100.00-$499.99	Less 15%
$ 500.00-$999.99	Less 20%
$1000.00 & Up	Less 25%

your BankAmericard welcome

Orders Accepted by Phone or Mail
MasterCharge • Bank-Americard • COD • Check • Money Order
P.O. Box 677, Thief River Falls, Minn. 56701 (218) 681-6674

DIGI-KEY CORPORATION

Quality Electronic Components

P.O. Box 677 Thief River Falls, MN 56701 (218) 681-6674

MORE THAN 20,000 DIFFERENT COMPONENTS

7400 TTL

7400	.18	7442	1.08	74107	.49
7401	.21	7448	1.15	74121	.55
7402	.21	7450	.26	74122	.49
7404	.21	7451	.27	74123	1.05
7405	.24	7453	.27	74125	.60
7407	.45	7454	.41	74126	.81
7408	.25	7460	.22	74132	3.00
7409	.25	7472	.39	74141	1.15
7410	.20	7473	.45	74150	1.10
7411	.30	7474	.45	74151	1.25
7413	.85	7475	.80	74153	1.35
7416	.43	7482	1.75	74154	1.54
7417	.43	7483	1.15	74157	1.30
7420	.21	7485	1.12	74161	1.45
7422	1.50	7486	.45	74164	1.65
7425	.43	7489	2.49	74165	1.65
7427	.37	7490	.69	74166	1.70
7428	.35	7491	1.20	74174	1.95
7430	.26	7492	.82	74175	1.95
7432	.31	7493	.82	74180	1.05
7437	.47	7494	.91	74181	3.55
7438	.40	7495	.91	74191	1.50
7440	.21	7496	.91	74195	1.00
7441	1.10	74100	1.25	74197	1.00

74L SERIES TTL

74L00	.33	74LS04	.45	74LS113	.98
74L10	.33	74LS10	.39	74LS138	1.89
74L30	.33	74LS20	.39	74LS174	2.50
74L42	1.50	74LS51	.39	74LS386	5.50
74L86	.69	74LS74	.65	74S153	2.25
74LS00	.39	74LS112	.65	74S387	1.95

74H00 TTL

74H00	.33	74H11	.33	74H53	.39
74H01	.33	74H20	.33	74H55	.39
74H04	.33	74H21	.33	74H73	.59
74H05	.35	74H30	.33	74H74	.59
74H10	.33	74H40	.33	74H76	.65

MOTOROLA

MC663P	2.50	MC1460	3.95
MC666P	1.60	MC1469R	2.50
MC670P	1.60	MC1489	4.60
MC679P	2.50	MC1496	1.65
MC725P	1.50	MC1510G	8.00
MC789P	1.50	MC1514L	4.50
MC790P	1.50	MC1595L	6.25
MC817P	1.30	MC1723CL	3.60
MC836P	1.35	MC1741CG	1.20
MC844	1.25	MC1810P	1.25
MC853P	2.25	MC3004L	2.25
MC876P	2.25	MC3007P	2.25
MC1004L	1.25	MC3021L	2.15
MC1010L	1.25	MC3060L	2.65
MC1305	1.95	MC3062L	3.00
MC1352P	1.55	MC4024P	2.20
MC1357	1.70	MC4044P	4.80
MC1371	1.85	MC14507CP	1.25
MC1439	2.65	MC14511CP	2.76
MC1458P	.50	MC14512CP	1.70

C MOS

4001AE	.29	4023AE	.29
4002AE	.29	4024AE	1.50
4007AE	.29	4025AE	.35
4010AE	.58	4028AE	1.60
4011AE	.29	4029AE	2.90
4012AE	.29	4030AE	.65
4015AE	1.25	4037AE	4.50
4016AE	.65	4040AE	2.40
4018AE	1.10	4044AE	1.50
4019AE	.65	4049AE	.75
4020AE	1.75	4050AE	.75
4021AE	1.50		

LINEAR

75450BP	.49	LM301H	.35	LM741CH	.45
75451BP	.39	LM307H	.35	LM747	.90
75452BP	.39	LM309K	1.25	LM748H	.45
75453BP	.39	LM311H	.90	LM1458N	.80
75454BP	.39	LM318N	1.50	N5556V	1.50
75491BP	.79	LM339N	1.85	NE5556	1.00
75492BP	.85	LM351AN	.65	NE555V	.60
CA3005	1.60	LM370N	1.25	NE556	1.50
CA3008	3.50	LM380N	1.45	UA702	.80
CA3018	1.10	LM566	2.25	UA703CH	.45
CA3018A	1.60	LM711CH	.60	UA709CH	.30
CA3028	1.50	LM723H	.75	UA749CH	.45
CA3046	.35	LM741CN	.45		

IC's ON THE MOVE

BBD BUCKET BRIGADE DEVICE

MM3001 19.50 MN3002 11.70

MM3003 9.45

HALL IC: DN834 1.25 DN837 1.50

DN835 1.35 DN838(NEW)

ZENER DIODES

½ Watt, ± 10% .... $.30 each to 33 V

1 Watt, ± 10% .... $.40 each to 33 V

Voltages to 200V, and ± 5% Available

1 Megohm Potentiometer - Made by Clarostat. 7/8" diam., split, knurled shaft ½" long.

NT544 $.39 Three for $1.00

5400 SERIES

5400	1.00	5475	1.50
5404	1.25	5486	1.90
5410	1.00	5493	2.00
5426	1.25	54100	1.80
5473	1.50	54LS04	1.00

VOLT.REG

LM340K-5	1.95
LM340K-6	1.95
LM340K-8	1.95
LM340K-15	1.95
LM340K-18	1.95
LM340K-24	1.95
LM340T0-5	1.75
LM340T0-6	1.75
LM340T0-8	1.75
LM340T0-12	1.75
LM340T0-15	1.75
LM340T0-18	1.75
LM340T0-24	1.75

RESISTORS

¼ Watt ± 5% Packed 5 of any one value .... $.25

½ Watt ± 5% Packed 5 of any one value .... $.30

STANDARD RESISTANCE VALUES

SEE OUR AD ON JAPANESE TRANSISTORS AND IC's IN THIS ISSUE.

MINIMUM ORDER $5.00

All orders add 1.00 Postage and Handling.

Canada $1.50

N.J. Residents add 5% sales tax

ELECTROLYTIC CAPACITORS

2.2MF50	Axial Leads	.15	30MF25	Axial Leads	.18
3.3MF10	Axial Leads	.15	47MF25	Radial Leads	.19
3.3MF10	No Polarity	.15	47MF50	Radial Leads	.24
10MF25	Axial Leads	.15	100MF16	Radial Leads	.19
10MF50	Axial Leads	.16	100MF25	Radial Leads	.24
10MF150	Axial Leads	.20	500MF50	Axial Leads	.60
25MF35	Axial Leads	.18	1000MF35	Axial Leads	.65

MICROPROCESSOR

C1702A	9.95	2708	34.95	8008	19.95
2101	5.75	C5101-3	4.50	8080A	19.95
2102	1.75	MM5013	3.25	8224	10.45

Contact us for all your microprocessor needs.

NEW FROM NEWTONE

Regulated Power Supply Components Kit - Contains the components needed to build a fixed-voltage regulated supply including: 117/17V- 1 ampere Transformer, Bridge Rectifier, 2000 uF Capacitor, and a 1 ampere LM340 3-terminal IC Regulator. Makes a fine "on board" supply or use it for breadboarding. Components only. Specify 5, 6, 8, 12 or 15 volts. **NT525 $4.99**

Pioneer 6" Speaker - 7½-watt, 3.2-ohm speaker made the way speakers should be made. Has heavy-duty treated paper cone, protected magnet housing, and a ceramic terminal strip marked with polarity. A beautiful speaker at half the price you'd expect. **NT526 $2.39 Three for $6.00**

PC Boards - MIL grade, 1/16" glass-epoxy boards with 2-ounce copper on one side.

NT521 6"x3" $.50, NT522 6"x6" $.90' NT523 6"x8" $1.20

Dry Transfer Patterns for PC Boards - Includes 0.1" spaced IC pads, donuts, angles, and 3-and 4-connector pads. Over 225 patterns on a 2" x 7¼" sheet. **NT520 $1.49**

3PDT - 24 Volt DC Relay - Potter & Bromfield KUP14D15. Each contact can handle 10 amperes at voltages to 240 Vac. Coil resistance is 450 ohms. A super buy! Limited quantities. **NT508 $.99**

5" Taunt-Band Meter - One milliampere full scale, 3½", scale length. Coil resistance 465 ohms. Made by Modutec for Bose. Meter scale in VUs (-20 to + 30). Meter is designed to be mounted coil up. Complete with "smoke" plastic cover. Over-all 5⅛"x4". Meter face mounts in a 5⅛"x2⅜" cutout: A beautiful meter. **NT539 $4.89**

Aluminum Knob - Solid machined aluminum knob with fluted sides made for Bose. Black front-face insert, black pointer line. Fits flat ¼" shaft, does not require set screws. .8 high, .7 diam. Easily worth $1.50 **NT540 $.82 2 for $1.50**

BOSE SPEAKERS

Bose has discontinued their original 301 System. New-Tone purchased the speakers remaining in inventory when the 301 was discontinued, and is offering them at prices that seem impossible. The speakers have been tested with the Bose "Tone Standard" as a reference and have been subjected to the Bose power-handling test which includes both fixed and sweep-frequency testing.

8-Inch Woofer (Bose Part No. 102606) has a free-air resonant frequency of 25-35 Hz., and has a 1.5", 8.5-ounce magnet. The upper tested-frequency is 4000 Hz.

3-Inch Tweeter (Bose Part No. 107376) has a free-air resonant frequency of 1200-1500 Hz., and has an upper tested-frequency of 16.5 kHz.

Supplies are limited. We urge you to take advantage of these prices and stock up for your future needs.

Sorry, we have no information about the Bose enclosures or the crossover networks, nor do we have more specs. Bose says these data are proprietary information.

8" Woofer NT541 $10.95

3" Tweeter NT542 $ 3.95

RECTIFIERS

	10 For	100 For
1N4001	.60	5.00
1N4002	.70	6.00
1N4003	.80	7.00
1N4004	.90	8.00
1N4005	1.00	9.00
1N4006	1.10	10.00
1N4007	1.20	11.00

UNIJUNCTIONS

2N2160	.65	MU4892	.50
2N2646	.45	MU4893	.50
2N2647	.55	MU4894	.50
2N4851	.75	2N6027	.55
2N4852	.75	2N6028	.70
2N4870	.50	D5E37	.35
2N4871	.50	MU10	.35
MU4891	.50	MU20	.40

HARDWARE - SOCKETS

Nylon Screws, Nuts and Rivets - 50 piece assortment		$1.99
MK 20 TO-3 Mounting Kit		5 for $.99
NT-505 Mica and bushing. Specify TO-3, TO-66 or TO-220		10 sets for $.99
IC Socket	14-Pin DIL	$.25 each
IC Socket	16-Pin DIL	$.27 each
Wire Wrap	16-Pin DIL	$.32 each

POPULAR JEDEC TYPES

1N34	.25	2N1540	.90	2N2712	.18	2N3394	.17	2N3856	.20	2N4402	.16
1N60	.25	2N1544	.80	2N2894	.40	2N3414	.17	2N3866	1.25	2N4403	.20
1N270	.25	2N1554	1.25	2N2903	3.30	2N3415	.18	2N3903	.16	2N4409	.20
1N914	.10	2N1560	2.80	2N2904	.25	2N3416	.19	2N3904	.16	2N4410	.16
1N4148	.25	2N1605	1.75	2N2904A	.30	2N3417	.20	2N3905	.16	2N4416	.75
1S1555	.35	2N1613	.50	2N2905	.25	2N3442	1.85	2N3906	.16	2N4441	1.00
		2N1711	.50	2N2905A	.30	2N3553	1.50	2N3954A	3.75	2N4442	1.15
2N173	1.75	2N1907	4.10	2N2906	.25	2N3563	.20	2N3955	2.45	2N4443	1.35
2N338A	1.05	2N2102	.70	2N2906A	.30	2N3565	.20	2N3957	1.25	2N4852	.55
2N404	.75	2N2160	.70	2N2907	.25	2N3638	.20	2N3958	1.20	2N5061	.30
2N443	2.50	2N2218	.25	2N2907A	.30	2N3642	.20	2N4037	.60	2N5064	.50
2N508A	.45	2N2218A	.30	2N2913	.75	2N3643	.20	2N4093	.85	2N5130	.20
2N706	.25	2N2219	.25	2N2914	1.20	2N3645	.20	2N4124	.16	2N5133	.15
2N718	.25	2N2219A	.30	2N3019	1.00	2N3646	.14	2N4126	.16	2N5138	.15
2N718A	.30	2N2221	.25	2N3053	.30	2N3731	3.75	2N4141	.20	2N5294	.50
2N918	.60	2N2221A	.30	2N3054	.70	2N3740	1.00	2N4142	.20	2N5296	.50
2N930	.25	2N2222	.25	2N3055	.75	2N3771	1.75	2N4143	.20	2N5306	.20
2N956	.30	2N2222A	.30	2N3227	1.00	2N3772	1.90	2N4220A	.45	2N5400	.40
2N1302	1.25	2N2270	.40	2N3247	3.40	2N3773	3.00	2N4234	.95	2N5401	.50
2N1305	.75	2N2369	.25	2N3250	.50	2N3819	.40	2N4400	.16	2N5457	.35
2N1420	.20	2N2484	.32	2N3393	.20	2N3823	.70	2N4401	.16	2N5458	.30

ALL PARTS GUARANTEED WRITE FOR FREE CATALOG

nte

NEW-TONE ELECTRONICS

PO BOX 1738A BLOOMFIELD, N.J. 07003

PHONE: (201) 748-6171, 6172, 6173

CIRCLE NO 41 ON FREE INFORMATION CARD

FOR ALL CUSTOMERS EXCEPT CALIF. CALL TOLL FREE 800-421-5809

MICROCOMPUTER

MICROPROCESSOR's

F-8	19.95
Z-80	25.00
Z-80A	35.00
CDP1802CD	24.95
AM2901	22.95
6502	12.95
6800	19 95
8008-1	8.75
8080A	15.95
TMS-9900TL	89.95

6800 SUPPORT

6810P	4 95
6820P	8.00
6828P	11.25
6834P	16.95
6850P	9.95
6852P	11.95
6860P	14.85
6862P	17 95
6880P	2.70

Z80 SUPPORT DEVICES

3881	12.95
3882	12.95

F-8 SUPPORT DEVICES

3851	14 95
3853	14 95

8080A SUPPORT DEVICES

8212	3.95
8214	9.95
8216	4.50
8224	4.95
8228	8.75
8238	8.00
8251	12.00
8253	28.00
8255	12.00
8257	25.00
8259	25 00

CHARACTER GENERATORS

2513 UP	6.75
2513 DOWN	6.75
2513 UP (5v)	9.95
2513 DOWN(5v)	10.95
MCM6571	10.80
MCM6571A	10.80
MCM6572	10.80
MCM6574	14.75
MCM6575	14.75

STATIC RAMS		1-24	25-99	100
21L02	(450)	1.50	1.40	1.25
21L02	(250)	1.95	1.80	1.50
21L11		4.25	4.10	3.95
1101A		1.49	1.29	1.10
2101 1		2.95	2 75	2.60
2102		1.25	1.15	1.00
2102-1		1.50	1.30	1.15
2111-1		4.00	3.50	3.25
2112-1		3.00	2.80	2.69
2114		17.95	16.95	16.50
4200A		12.95	12.50	11.95
5101C E		11.95	11.25	10.25

WAVEFORM GENERATOR

8038	4 00
MC4024	2 50
566	1 75

KEYBOARD CHIPS

AY5-2376	13.95
AY5-3600	13.95

LATE ADDITIONS

TMS 4044	$14.00
TMS 5501	$24.95

FLOPPY DISC CONTROLLER

1771B	55.95
1771B-01	59.95

PROM'S

1702A	5.00
2704	15.00
2708	13.00
2716	38.00
3601	4.50
5203AQ	4.00
5204AQ	6.00
6834	16.95
6834-1	14.95
82S23B	4.00
8223B	2.70

DYNAMIC RAMS

1103	1 50
2104	4 50
2107A	3 75
2107B	4.50
2107B-4	4.00
TMS4050	4 50
TMS4060	4.50
4096	4 50
4116	42 00
MM5270	5 00
MM5280	6 00
MCM6605	6.00

UART'S

AY5-1013A	5.50
AY5-1014A	8.95
TR-1602A	5.50
TMS-6011	6.95
IM-6402	10.80
IM-6403	10 80

MISC. OTHER COMPONENTS

NH0025CN	1.70
NH0026CN	2.50
N8T20	3.50
N8T26	2.45
74367	.90
DM8098	.90
1488	1.95
1489	1.95
D-3207A	2.00
C-3404	3.95
P-3408A	5.00
P-4201	4.95
MM-5320	7.50
MM-5369	1.90
DM-8130	2.90
DM8131	2.75
DM-8831	2.50
DM-8833	2.50
DM-8835	2.50
SN74LS367	.90
SN74LS368	.90

KIM

KIM-1	245.00
6502	12.95
6520	9.00
6522	9.25
6530-002	15.95
6530-003	15.95
6530-004	15.95
6530-005	15.95

USRT

S-2350	10.95

8K STATIC RAM BOARD

ASSEMBLED & TESTED

250ns. $199.95
450ns. $150.00

* WILL WORK WITH NO FRONT PANEL
* FULL DOCUMENTATION
* FULLY BUFFERED
* S100 DESIGN
* ADEQUATELY BYPASSED
* LOW POWER SCHOTTKY SUPPORT IC'S

KIT

250ns. $169.95
450ns. $129.95

BARE BOARD $25.00
W/SCHEMATIC

ADAPT YOUR MOTOROLA 6800 SYSTEM TO OUR S-100 8K RAM BOARD. KIT PRICE $12.95

JADE VIDEO INTERFACE KIT

FEATURES $89.95

S-100 Bus Compatible
32 or 64 Characters per line
16 lines
Graphics (128 x 48 matrix)
Parallel & Compositive video
On board low-power memory

Powerful software included for cursor, home, EOL, Scroll Graphics/Character, etc.
Upper case, lower case & Greek
Black-on-white & white-on-black

JADE PARALLEL/SERIAL INTERFACE KIT

S-100 $124.95 KIT

2 Serial Interfaces with RS232 interfaces or 1 Kansas City cassette interface.
Serial interfaces are crystal controlled.
Selectable baud rates.
Cassette works up to 1200 baud.
1 parallel port.

EDGE CONNECTORS

S-100 Altair Spacing $4.45
S-100 Imsai Spacing $4.45

IMSAI/ALTAIR S-100 COMPATIBLE

JADE Z80 KIT

—with PROVISIONS for ONBOARD 2708 and POWER ON JUMP

$135.00 EA. (2MHZ)
$149.95 EA. (4MHZ)

BARE BOARD $35.00

MOTHER BOARD

* 13 SLOT MOTHER BOARD w/front panel slot
* S-100 DESIGN
* FULL GROUND PLANE ON ONE SIDE
* RC NETWORK TERMINATION ON EVERY LINE EXCEPT PWR & GRD
* KLUGE AREA
* STRONG 1/8" THICK DOUBLE SIDED BOARD

BARE BOARD $35.00 KIT $85.00

THE PROM SETTER

WRITE and READ EPROM

1702A-2708-2716
5204-6834

* Plugs Directly into your ALTAIR/IMSAI Computer
* Includes Main Module Board and External EPROM Socket Unit
* The EPROM Socket Unit is connected to the Computer through a 25 Pin Connector
* Programming is accomplished by the Computer
* Just Read in the Program to be Written on the EPROM into your Processor and let the Computer do the rest
* Use Socket Unit to Read EPROM's Contents into your Computer
* Software included
* No External Power Supplies. Your Computer does it all
* Doubles as an Eight Bit Parallel I/O
* Manual included — Delivery Less than 90 days

THE PROM SETTER
KIT $210.00 — ASSEMBLED $375.00

JADE 8080A KIT

$100.00 KIT

BARE BOARD $35.00

PERSCI DISK DRIVE FOR S-100

Info 2000 S-100 DISK SYSTEM IMP COMPLETE
Info 2000 S-100 DISK SYSTEM
(includes dual drive, power supply, case, intelligent controller, adapter, cables, and disk monitor on EPROM) $2,650.00

COMPLETE TDL SOFTWARE PKG. FOR DISK $195.00

REAL TIME CLOCK FOR S-100 BUS

BARE BOARD $30.00 KIT $124.95

TV-1 VIDEO INTERFACE

You will want to know about the TV-1 Video to Televisior Interface Kit.
No need to buy a separate Video Monitor if you already own a TV set. Just connect the TV-1 between your system video output and the TV set antenna terminals - that's all there is to it - to convert your TV set to a Video Monitor, and at a much lower cost! PRICE $8.95

SOROC IQ 120 TERMINAL

A CAPABLE LOW COST. APPROACH TO REMOTE VIDEO DISPLAY TERMINALS.

* Cursor Control Keys Standard
* Numeric Key Pad Standard
* Line and Page Erase Standard
* Addressable Cursor Standard
* Switch Selectable Transmission from 75 to 19,200 bps Standard
* Communication Mode. HDX/FDX Block
* Interfaces. Printer Interface. RS232 Extension
* RS232C Interface
* Non-Glare Read Out Screen
* Protect Mode Standard
* Tab Standard

$975 00
Assembled

Price Includes
* Block Mode
* Lower Case
* 24 Line Option
* and shipping charge is on us.

JADE
Computer Products
5351 WEST 144th STREET
LAWNDALE, CALIFORNIA 90260
(213) 679-3313

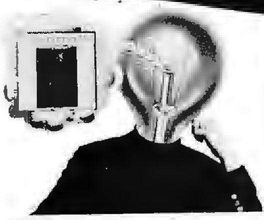
RETAIL STORE HOURS M-F 9-7 SAT. 9-5

Discounts available at OEM quantities. Add $1.25 for shipping. California residents add 6% sales tax.

ELECTRONICS Market Place

CIRCLE NO. 36 ON FREE INFORMATION CARD

EDMUND SCIENTIFIC



ENVIRONMENTS

- **Strange, beautiful records that can help you think**

Scientifically designed to help you study, read, meditate, romance or eliminate unwanted noise, these long-playing 33⅓ rpm reacords provide a unique tranquil experience. Each provides one hour of naturally occuring sounds that range from soothing surf to thunderstorm.

A) Seashore/Aviary—surf on one side, melodic birds on other. **No. 72,156 AV**

B) Thunderstorm/Rain in Forest—beautifully realistic rainfall. **No. 72,157AV**

$7.25 ea. Ppd.

CROOKE'S RADIOMETER powered by sunlight

Fascinating solar rotor spins at 3,000 RPM. First-surface silvering on ½ dome makes hemispherical mirror. 5x3".

No. 60,529AV **$5.75** Ppd.

SUPER POWER FOR ANY AM RADIO

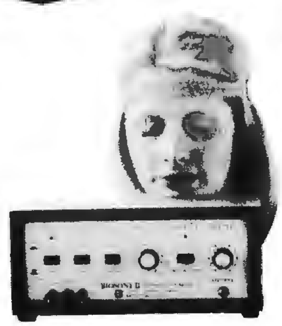
Antenna assist has pulled in station 1,000 miles off! No wires, clips, grounding. Solid state. No batteries, tubes, plugs.

No. 72,095AV **$19.95** Ppd.

ULTRA SELECT-A-TENNA No. 72,147AV **$24.95** Ppd.

Free Catalog

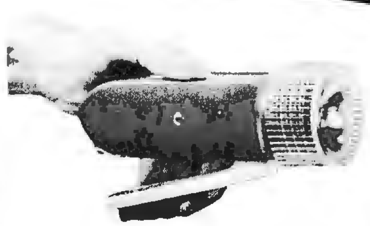
KNOW YOUR ALPHA FROM THETA!



For greater relaxation & concentration, monitor your Alpha/Theta brainwaves with audio or visual signals on Biosone II. Features of $200-up units. 3 feedback modes! 4-lb.

No. 1668AV (9½x5⅝x4¼")
$149.95 Ppd.

No. 71,809AV (FOR BEGINNERS)
$59.95 Ppd.

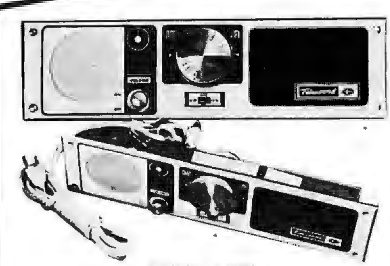


FLYWHEEL GENERATOR FLASHLIGHT

Never needs batteries, uses a flywheel generator to keep light bright. Each squeeze of handle gives 2 sec. flash of light. Continuous squeezing keeps light shining. Only 6-oz.

No. 61,086AV **$14.95** Ppd.

Send for your FREE 164 page Edmund Scientific Catalog with over 4000 bargains



SAVE 40% — DELUXE AM/FM WALL RADIO

Great surplus buy saves you 40% on brand new AM/FM Deluxe Wall Radio w/ handsome silver/black control panel. Mount anywhere den, kitchen, bedroom, office, workshop. Self-cont. Philco-Ford radio chassis (14¼x3$^{13}/_{16}$x3½") w/11 transistors, vol. control, AM/FM hi-sensitivity tuner, AFC, 2¾" dia. speaker, 7½' 110V AC cord. Orig. cost $30 ea. in 3000 quant. for nat'l motel chain. Buy several now.

No. 72,275AV (READY TO PLAY!) **$17.50** Ppd.

ORDER *FREE CATALOG* HERE

TO ORDER PRODUCTS USE THIS COUPON

EDMUND SCIENTIFIC CO.
Dept. AV08, Edscorp Bldg.
Barrington, New Jersey 08007

Send GIANT 164 Page Catalog packed with unusual bargains.

Name ____________________
(Please Print)
Address ____________________
City ____________________
State __________ Zip __________

EDMUND SCIENTIFIC CO.
Dept. AV07, Edscorp Bldg.
Barrington, N.J. 08007

Enclosed please find check/M.O.
Charge My ☐ Amer. Exp. ☐ BAC (VISA) ☐ MC
Interbank # ______ Acct. # ______
Card # ______ Exp. Date ______
Sig. ______

☐ **Please send me the following items I have indicated below:**

Stock No.	Qty.	Price
N.J. residents add 5% sales tax.	Handling	$1.00

30 DAY GUARANTEE
You must be completely satisfied with any Edmund item or return it within 30 days for a full refund.

Name ____________________
Address ____________________
City __________ State __________ Zip __________

FREE INFORMATION:

Learning more about a product that's advertised or mentioned in an article in this month's issue is as simple as one, two, three. And absolutely free.

1 Print or type your name and address on the attached, card. Use only one card per person.

2 Circle the number(s) on the card that correspond to the number(s) at the bottom of the advertisement or article for which you want more information.
(Key numbers for advertised products also appear in the Advertisers' Index.)

3 Simply mail the card, and the literature will be mailed to you free of charge from the manufacturer.

FREE INFORMATION:

This address is for our product Free Information Service only. Editorial inquiries should be directed to POPULAR ELECTRONICS, One Park Avenue, New York, N.Y. 10016.

POPULAR ELECTRONICS

PE4782

USE ONLY ONE CARD PER PERSON

NAME ______________________________

ADDRESS ______________________________

CITY ______________ STATE __________ ZIP _____

(Zip Code must be included to insure delivery.) (Void after June 30,1978)

Do You construct projects found in our editorial pages?

☐A Yes ☐B No

4 ☐ Please send me 12 issues of Popular Electronics for $7.97 and bill me.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120

POPULAR ELECTRONICS

PE4781

USE ONLY ONE CARD PER PERSON

NAME ______________________________

ADDRESS ______________________________

CITY ______________ STATE __________ ZIP _____

(Zip Code must be included to insure delivery.) (Void after June 30,1978)

Do You construct projects found in our editorial pages?

☐A Yes ☐B No

4 ☐ Please send me 12 issues of Popular Electronics for $7.97 and bill me.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120

First Class
Permit No. 217
Clinton, Iowa

BUSINESS REPLY MAIL
No postage necessary if mailed in the United States

POSTAGE WILL BE PAID BY

Popular Electronics

P.O. Box 2905
Clinton, Iowa 52732

Popular Electronics

Reprint series

Many important articles covering a variety of interests in the broad field of electronics are published in POPULAR ELECTRONICS. Reprints of selected articles and test reports are now available in the event that you missed some you would like to have for reference or study purposes—or for projects you wish to build. Reprints in this series are only $1 each (*75¢ for those marked with an asterisk.) Minimum order is $2.

TEST REPORTS

AUDIO

18. ADC Accutrac 4000 Record Player
19. *Empire Model 698 Manual Turntable
20. Kenwood Model 600 Integrated Stereo Amplifier
21. *MXR Stereo Graphic Equalizer
22. *Nakamichi Model 500 Stereo Cassette Deck
23. Onkyo Model TX-4500 AM/Stereo FM Receiver
24. *Ortofon MC20 Moving Coil Phono Cartridge
25. *Pickering Model XV-15/625E Stereo Phono Cartridge
26. Pioneer Model CT-F8282 Stereo Cassette Deck
27. Radio Shack "Realistic" Model STA-2000 AM/Stereo FM Receiver
28. Rotel RX-7707 AM/Stereo FM Receiver
29. Sansui Model TU-9900 AM/Stereo FM Tuner
30. *Shure Model M24H Stereo Phono Cartridge
31. *Sony Model TA-4650 V-FET Stereo Power Amplifier
32. *Spectro Acoustics Model 210 Stereo Graphic Equalizer
33. *Stanton Model 681EEE Stereo Phono Cartridge
34. Teac Model PC-10 Portable Stereo Cassette Deck
35. *Technics Model SB-6000A Linear Phase Speaker System
36. *Thorens Model TD-126C Record Player

COMMUNICATIONS

37. *Cobra Model 29XLR 40-Ch. AM CB Mobile Transceiver
38. *Drake Model SSR-1 AM/SSB Communications Receiver
39. *Kenwood Model TS-820 Amateur Radio Transceiver
40. *Kris Model XL-50 40-Ch. AM CB Mobile Transceiver
41. *President Model "Washington" 40-Ch. AM/SSB CB Base Station
42. Yaesu Model FRG-7 AM/SSB Communications Receiver

*REPRINTS MARKED WITH ASTERISK 75¢;
ALL OTHERS $1.00. MINIMUM ORDER $2.00.

HERE'S HOW TO ORDER

Mail your order along with your name, address and remittance in the amount of $1.00 for each reprint; 75¢ for reprints marked with asterisk. Residents of CA, CO, FL, IL, MI, MO, NY STATE, DC and TX add applicable sales tax.

Please be sure you identify reprints being ordered by the appropriate numbers shown above.

OUTSIDE U.S.A. ADD $1 PER ORDER. MINIMUM ORDER $2.

ORDER FROM: POPULAR ELECTRONICS REPRINTS, P.O. BOX 278, PRATT STATION, BROOKLYN, N.Y. 11205.

THIS SPECIAL ONE CENT SALE IS FOR MAGAZINE ADS ONLY

POLY PAKS IS THE NEW WORLD'S 'CENT-ER' FOR DOUBLING YOUR MONEY

THIS NEW LIST OF "ONE-CENTERS" HELPS FIGHT INFLATION!

LEDS!

YOUR CHOICE 5 for $1.00
1¢ SALE 10 for $1.01

Order by Cat. No.

- ☐ #4E2135 ... JUMBO RED LEDS
- ☐ #4E2137 ... MICRO RED LEDS
- ☐ #4E2790 ... JUMBO RED CLEAR LEDS
- ☐ #4E2792 ... JUMBO TAPERED AMBER
- ☐ #4E2140 ... MICRO GREEN LEDS

1.5 AMP BULLET RECTIFIERS!

Order by Cat. No. 4E60B84 and voltage

☐ 50V	10 for $.59	20 for $.60
☐ 100V	10 for .69	20 for .70
☐ 200V	10 for .79	20 for .80
☐ 400V	10 for .89	20 for .90
☐ 600V	10 for 1.09	20 for 1.10
☐ 800V	10 for 1.19	20 for 1.20

OP AMP 1¢ GIVEAWAYS

Order by Type Number

Type	Sale	1¢SALE
☐ LM308V	2 for $1.00	4 for $1.01
☐ LM311V	2 for 1.00	4 for 1.01
☐ LM558V	3 for 1.19	6 for 1.20
☐ LM709H	10 for 1.19	20 for 1.20
☐ LM741V	5 for 1.19	10 for 1.20
☐ LM1800N	1 for .99	2 for 1.00
☐ LM3900N	2 for 1.00	4 for 1.01

MICRO MINI TOGGLE SWITCHES!

3 Amps, 125 VAC contacts, with chrome handles, complete with mounting hardware.

Cat. No	Type	Sale	2 for
☐ 4E3936	SPDT	$1.29	$1.30
☐ 4E5085	SPDT*	1.39	1.40
☐ 4E4037	DPDT	1.45	1.46
☐ 4E5087	4PDT*	1.95	1.96

BUY 1 AT OUR SALE PRICE — GET 2 FOR 1¢ MORE

4 DIGIT FLUORESCENT CLOCK BASIC KIT

12 or 24 hours! .57" bright blue digits! Easy to breadboard, uses MM5316 clock chip and minimum of external components! AM—PM indicator, includes options for alarm, clock-radio, snooze, and more! Basic kits include readouts, ICs, sockets, transistors & all necessary components! (case, PC board, transformer, line chord not included). Requires 12VCT transformer.

- ☐ #4E3791 Fluorescent Basic Kit .... $9.95, 2 kits $9.96
- ☐ #4E3792 Components for optional alarm . $2.95 (No 1¢ sale)
- ☐ #4E3686 12VCT "pluggable" transformer . 1.95 (No 1¢ sale)

POLY PAKS® BIGGEST 1¢ GIVEAWAY SALE!

IT MAKES "CENTS" TO GIVE OUR CUSTOMERS THE BEST BARGAINS!

TTL'S, BUY ONE AT SALE PRICE, GET 2ND FOR ONLY 1¢ MORE

Honest Abe Penny Sale!

Order By Cat. No. 4E1981 & Type No.

Type	Each	2 for
☐ SN7400	$.19	$.20
☐ SN7401	.19	.20
☐ SN7403	.19	.20
☐ SN7404	.25	.26
☐ SN7405	.19	.20
☐ SN7406	.19	.20
☐ SN7408	.21	.22
☐ SN7410	.19	.20
☐ SN7413	.39	.40
☐ SN7414	.65	.66
☐ SN7416	.29	.30
☐ SN7420	.19	.20
☐ SN7423	.29	.30
☐ SN7426	.25	.26
☐ SN7427	.25	.26
☐ SN7430	.29	.30
☐ SN7432	.25	.26
☐ SN7437	.25	.26
☐ SN7438	.29	.30
☐ SN7440	.19	.20
☐ SN7442	.69	.70
☐ SN7443	.69	.70
☐ SN7444	.65	.66
☐ SN7445	.99	1.00
☐ SN7446	1.35	1.36
☐ SN7447	1.25	1.26
☐ SN7448	1.35	1.36
☐ SN7450	.19	.20
☐ SN7451	.19	.20
☐ SN7453	.19	.20
☐ SN7454	.19	.20
☐ SN7455	.19	.20
☐ SN7460	.19	.20
☐ SN7462	.19	.20
☐ SN7464	.19	.20
☐ SN7465	.19	.20
☐ SN7470	.25	.26
☐ SN7471	.25	.26
☐ SN7472	.25	.26
☐ SN7473	.55	.56
☐ SN7474	.29	.30
☐ SN7475	.79	.80
☐ SN7476	.59	.60
☐ SN7478	.59	.60
☐ SN7480	.29	.30
☐ SN7482	.39	.40
☐ SN7483	.99	1.00
☐ SN7485	1.49	1.50
☐ SN7486	.39	.40
☐ SN7488	1.95	1.96
☐ SN7490	.69	.70
☐ SN7491	.79	.80
☐ SN7492	.45	.46
☐ SN7493	.49	.50
☐ SN7494	.69	.70
☐ SN7495	.69	.70
☐ SN7496	.69	.70
☐ SN7498	.69	.70
☐ SN74100	1.49	1.50
☐ SN74107	.39	.40
☐ SN74112	.25	.26
☐ SN74113	.19	.20
☐ SN74114	.25	.26
☐ SN74121	.49	.50
☐ SN74123	.69	.70
☐ SN74125	.59	.60
☐ SN74126	.39	.40
☐ SN74132	1.25	1.26
☐ SN74140	.99	1.00
☐ SN74141	1.49	1.50
☐ SN74145	1.25	1.26
☐ SN74148	1.75	1.76
☐ SN74150	.99	1.00
☐ SN74151	.99	1.00
☐ SN74153	.99	1.00
☐ SN74154	1.75	1.76
☐ SN74155	.79	.80
☐ SN74156	.69	.70
☐ SN74157	.99	1.00
☐ SN74158	.99	1.00
☐ SN74160	1.25	1.26
☐ SN74161	1.25	1.26
☐ SN74163	1.19	1.20
☐ SN74164	.99	1.00
☐ SN74165	1.25	1.26
☐ SN74166	1.25	1.26
☐ SN74173	1.25	1.26
☐ SN74174	1.49	1.50
☐ SN74175	.99	1.00
☐ SN74177	.79	.80
☐ SN74179	1.49	1.50
☐ SN74180	.49	.50
☐ SN74182	.69	.70
☐ SN74190	1.49	1.50
☐ SN74191	1.75	1.76
☐ SN74192	.85	.86
☐ SN74193	.85	.86
☐ SN74194	1.25	1.26
☐ SN74195	.49	.50
☐ SN74197	.75	.76
☐ SN74199	1.75	1.76
☐ SN74200	5.50	5.51
☐ SN74251	1.75	1.76
☐ SN74284	4.50	4.51
☐ SN74285	4.25	4.26

POP-AMPS AT "CENT-CIBLE" PRICES

Buy ONE At Sale Price, Get 2ND For Only 1¢ More - Order By Type No.

Type	Each	2 for
☐ LM300H	$.49	$.50
☐ LM301H-V	.45	.46
☐ LM308V-H	.79	.80
☐ LM309K	1.29	1.30
☐ LM311H-V	.79	.80
☐ LM318V	1.29	1.30
☐ LM320H-5, 12, 15	1.29	1.30
☐ LM320K- 15	1.29	1.30
☐ LM320T-6, 5	1.29	1.30
☐ LM322N	1.19	1.20
☐ LM324N	1.75	1.76
☐ LM339N	1.09	1.10
☐ LM340K-5, 6, 8, 12,15, 18,	1.29	1.30
☐ LM340T-5, 6, 8, 12,15, 18, 24	1.29	1.30
☐ LM350N	.59	.60
☐ LM370N-H	1.29	1.30
☐ LM374H	1.79	1.80
☐ LM376V	.29	.30
☐ LM377N	2.25	2.26
☐ LM381N	1.69	1.70
☐ LM531H	1.49	1.50
☐ LM532H-N	.29	.30
☐ LM555V	.75	.76
☐ LM558V	.79	.80
☐ LM561N	1.00	1.01
☐ LM565N	.99	1.00
☐ LM703H	.49	.50
☐ LM704H	.29	.30
☐ LM709N-H	.25	.26
☐ LM710N	.39	.40
☐ LM733N	.79	.80
☐ LM739N	.89	.90
☐ LM741V-H	.30	.29
☐ LM1304	.80	.79
☐ LM1310	1.00	.99
☐ LM1312	2.00	1.99
☐ LM1414V	.80	.79
☐ LM1458V	.70	.69
☐ LM1800N	1.00	.99
☐ LM3028H	.66	.65
☐ LM3900N	.50	.49
☐ LM3909V	1.76	1.75
☐ LM4195	1.96	1.95
☐ LM4250	1.20	1.19
☐ LM75451	.40	.39
☐ LM75453	.40	.39
☐ LM75491	.80	.79
☐ LM75492	.80	.79
☐ LM75494	.60	.59
☐ PA263	1.50	1.51

PENNY SALE PRICES LISTED ARE GOOD TILL MAY 15, 1978
WE RESERVE THE RIGHT TO LIMIT QUANTITIES!!!!!!

Mail your order in & save many dollars!

Quan.	Description (Order by Cat. No. in parenthesis)	Sale	1¢SALE
☐ 10	CALCULATOR KEYBOARDS, 20 keys and more (4E3524)	$2.00	20 for $2.01
☐ 15	SLIDE VOLUME CONTROLS, asstd values (4E3057)	2.00	30 for 2.01
☐ 10	CRYSTALS, may include CB, Ham & more (4E3250)	2.00	20 for 2.01
☐ 150	MOLEX IC SOCKETS, on a strip, cut to length (4E3144)	2.00	300 for 2.01
☐ 100	TERMINAL STRIPS, from 2 lugs up (4E3136)	2.00	200 for 2.01
☐ 30	NE-2NEON LAMPS, all 100% good (4E2613)	2.00	60 for 2.01
☐ 40	SHIELDED CABLE, 1 cond, mikes, phonos (4E3577)	2.00	80 for 2.01
☐ 50	TRANSISTOR ELECTROS, asstd values, styles (4E2747)	2.00	100 for 2.01
☐ 3	SOUND TRIGGERS, sound triggers scr w/amp (4E3625)	2.00	6 for 2.01
☐ 15	6V TEST INDICATORS, leads, grain-o-wheat (4E3526)	2.00	30 for 2.01
☐ 100	CAPACITOR SPECIAL, discs, mylar, lytics, more (4E2738)	2.00	200 for 2.10
☐ 30	MINI TRIMPOTS, to 1 meg, 1 turn, ¼W (4E3345)	2.00	60 for 2.01
☐ 10	VOLTAGE REGULATORS, hobby LM320, 340, TO-3 (4E3330)	2.00	20 for 2.01
☐ 30	PANEL SWITCHES, slides, rotaries, mod, etc (4E3268)	2.00	60 for 2.01
☐ 200	RESISTOR SPECIAL, ¼ to 1W, carbon, metal (4E3054)	2.00	400 for 2.01
☐ 200	HALF WATTERS, resistors, carbon, metal (4E3046)	2.00	400 for 2.01
☐ 100	NATIONAL IC BONANZA, linears, 7400s ROMS (4E2860)	2.00	200 for 2.01
☐ 40	HOBBY LEDS, asstd types, mostly useable (4E2859)	2.00	80 for 2.01
☐ 15	LM340T VOLTAGE REGULATAORS, 5 to 24V, TO-220 (4E2635)	2.00	30 for 2.01
☐ 100	TWO WATTERS, resistors, carbon-metal marked (4E2735)	2.00	200 for 2.01
☐ 100	POLYSTYRENE CAPS, asstd values, voltage, hi-Q (4E2729)	2.00	200 for 2.01
☐ 50	THERMISTORS, resistors that change with temp (4E4089)	2.00	100 for 2.01
☐ 20	BRIDGES, untested, 2, 4, 6, 10, amp, full wave (4E4022)	2.00	40 for 2.01
☐ 25	LAMP'N'SOCKET SETS, micro, 1.5V, T2 (4E3957)	2.00	50 for 2.01
☐ 15	MIXED READOUTS, hobby, untested, .127, .3, .5, etc. (4E3619)	2.00	30 for 2.01
☐ 150	QUARTER WATTERS, resistors, metal film, marked (4E3413)	2.00	300 for 2.01
☐ 100	PLASTIC TRANSISTORS, untested, RO-92 (4E2604)	2.00	200 for 2.01
☐ 200	PREFORMED RESISTORS, ¼, ½, 1W, marked, asstd (4E2608)	2.00	400 for 2.01
☐ 200	PRECISION RESISTORS, ¼, ½, 1W, 1%, 2% marked (4E2428)	2.00	400 for 2.01
☐ 60	DIPPED MYLARS, shiny finish, asst values (4E2597)	2.00	120 for 2.01
☐ 30	VOLUME CONTROLS, audio, linear, asstd values (4E2421)	2.00	60 for 2.01
☐ 5	7.5 VOLT ZENER DIODES, 1 watt (4E5187)	1.00	10 for 1.01
☐ 5	9.1 VOLT ZENER DIODES, 1 watt (4E5188)	1.00	10 for 1.01
☐	30-FT. WIRE WRAP WIRE, 30 gauge (4E3803)	1.19	60-ft for 1.20
☐ 5	TANTALUM CAPS, 2.2uF, 25V (4E5189)	1.00	10 for 1.01
☐ 1	TV GAME SWITCH, choose TV or game, 75 pr 300 ohms (4E3970)	1.50	2 for 1.51
☐ 1	ALARM CLOCK CHIP, MM5316, 4-digits (4E1759)	2.95	2 for 2.96
☐ 5	PANCAKE PHOTOCELLS, 600 to 15K ohms (4E2939)	1.00	10 for 1.01
☐ 1	100KHZ MARKER CRYSTALS, approx for marker gen. (4E3896)	1.95	2 for 1.96
☐ 1	MOTHERBOARD EDGE CONNECTOR, 106 pins, .125" (4E3987)	3.50	2 for 3.51
☐ 1	48-PIN EDGE CONNECTOR, .156" spacing (4E3963)	1.95	2 for 1.96
☐ 1	JOYSTICK, two 10K pots, for computers, TV games (4E5037)	2.95	2 for 2.96
☐ 1	CHARACTER GENERATOR, 5 × 7 Mostek MK 2002P (4E3898)	4.95	2 for 4.96

READOUTS!

		ONE CENT SALE
☐ 3½ DIGIT LCD WRISTWATCH DISPLAY, (#4E3960)	3 for $1.19	6 for $1.20
☐ GE FLUORESCENT NIXIES, 7-seg, blue (#4E3684)	1 for 1.00	2 for 1.01
☐ SPERRY FLAT NIXIES, orange dual digit (#4E5014)	2 for 1.19	4 for 1.20
☐ SPERRY FLAT NIXIES, orange, .3", 1½-dig (#4E5015)	2 for 1.19	4 for 1.20
☐ MAN-3 BUBBLE READOUT, .19" red, com cath. (#4E3338)	6 for 1.00	12 for 1.01
☐ MAN-4 READOUT, bubble, red, com anode (#4E1503)	2 for 1.00	4 for 1.01
☐ FND-10 BLOCK READOUT, .122" com cathode (#4E2082)	2 for 1.19	4 for 1.20
☐ 8-DIGIT READOUT, led, com cathod, red (#4E5190)	1 for 1.95	2 for 1.96

SPEAKERS!

	Each	2 for
☐ 6" TWIN CONE SPEAKER, hi-fi, for car'n'home (#4E5059)	$4.50	$4.51
☐ 2¼ × 5" OVAL SPEAKER, 8 ohms (#4E2553)	1.49	1.50
☐ 2 × 6" OVAL SPEAKER, 8 ohms (#4E3454)	1.49	1.50

MICROPHONES!

	Each	2 for
☐ CONDENSOR MIKES, sensitive, 500 ohms, 1½V (#4E3178)	$4.95	$4.96
☐ COMMUNICATIONS MIKE, 500 ohms, CB-HAM (#4E4074)	4.50	4.51
☐ NOISE CANCELLING MIKE, Ham-CB, 500 ohms (#4E3902)	6.95	6.96

RELAYS!

	Each	2 for
☐ SPDT 12V BLOCK RELAY, 5A contacts (#4E4032)	$1.98	$1.99
☐ SPDT 12V REED RELAY, 1A contacts (#4E4094)	1.49	1.50
☐ SPDT 12V SENSITIVE, 2000 ohm coil (#4E3044A)	1.95	1.96

AMPLIFIERS!

	Each	2 for
☐ 8 WATTS ON A BOARD, with built-in preamp (#4E5040)	$5.95	$5.96
☐ 9 WATTS ON A CHIP, Toshiba TA720S (#4E5057)	4.95	4.96
☐ 3 WATTS ON A CHIP, G-E PA 263 (#4E1522)	1.50	1.51

TRANSFORMERS!

	Each	2 for
☐ 12V TRANSFORMER, 300ma, pc leads, 110prl. (#4E3412)	$1.49	$1.51
☐ 12V TRANSFORMER, 1A, 110/220prl, open frame (#4E4040)	2.95	2.96
☐ 24VCT TRANSFORMER, 300ma, open frame, 110prl. (#4E3323)	1.95	1.96

DIP SWITCHES!

	Each	2 for
☐ 2 SWITCHES ON A DIP (#4E3668)	$ .77	$ .78
☐ 3 SWITCHES ON A DIP (#4E3669)	.88	.89
☐ 6 SWITCHES ON A DIP (#4E3671)	1.29	1.30

IC SOCKETS!

☐ 8-PIN MINI-DIP (#4E2123)	4 for $1.19	8 for $1.20
☐ 14-PIN DIP (#4E1308)	3 for 1.19	6 for 1.20
☐ 16-PIN DIP (#4E1309)	3 for 1.19	6 for 1.20
☐ 18-PIN DIP (#4E3378)	6 for 1.19	12 for 1.20
☐ 24-PIN MSI/DIP (#4E3886)	2 for 1.19	4 for 1.20
☐ 28-PIN MSI/DIP (#4E3887)	2 for 1.19	4 for 1.20
☐ 8-PIN TO-5 (#4E1307)	4 for 1.19	8 for 1.20

FULL WAVE 10 AMP BRIDGE RECTIFIERS!

Order by Cat. No. 4E2447 & voltage

PRV	Sale	2 for
☐ 50	$1.29	$1.30
☐ 100	1.49	1.50
☐ 200	1.69	1.70
☐ 400	1.99	2.00
☐ 600	2.25	2.26
☐ 800	2.50	2.51

RIBBON CABLE!

Order by Cat. No. 4E3939 and Conductors

Cond.	Sale	1¢ Sale
☐ 20	7-ft. $1.98	14-ft. $1.99
☐ 26	4-ft. 1.98	8-ft. 1.99
☐ 34	3-ft. 1.98	6-ft. 1.99
☐ 40	3-ft. 1.98	6-ft. 1.99

2-Amp Epoxy BRIDGE RECTIFIERS!

PENNY SALE! BUY ONE AT SALE PRICE, GET 2ND FOR ONLY 1¢ MORE

• Full Wave! | • TO-5 case!

Order by Cat. No.4E1346 and PIV

PIV	Sale Each	2 for
☐ 50	$.59	$.60
☐ 100	.69	.70
☐ 200	.79	.80
☐ 400	.89	.90
☐ 600	.99	1.00
☐ 800	1.19	1.20
☐ 1000	1.29	1.30

10 AMP - POWER TABS! SCRS! TRIACS! QUADRACS!

Order by Cat. No. and voltage!
#4E1448 - TRIACS #4E730 - SCRS
#4E1590 - QUADRACS

PRV	Sale	2 for
☐ 50	$ .55	$ .56
☐ 100	.69	.70
☐ 200	.88	.89
☐ 300	1.19	1.20
☐ 600	1.59	1.60

SPECTROL "SKINNY-TRIMS"

Ohms

☐ 10**	
☐ 50**	
☐ 100**	☐ 5K*
☐ 200**	☐ 10K*
☐ 500*	☐ 20K**
☐ 1K*	☐ 50K**
☐ 2K**	☐ 100K**

3/8" square, screwdriver shaft, 2% tol. 1/4 watt. Cermet. PC leads. Order by Cat. No. and value.

Your Choice **2 for $1**

- ☐ No. 4E3863 25 turn upright, type 64
- ☐ No. 4E3866 single turn, flat, type 63

WRITE FOR POLY PAKS CATALOG FEATURING BEST BARGAINS IN ELECTRONICS — FREE!

Terms: Add postage Rated: net 30
Phone: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield.

MINIMUM ORDER — $6.00

POLY PAKS®

C.O.D.'s MAY BE PHONED

P.O. BOX 942E
LYNNFIELD, MA.

CIRCLE NO. 49 ON FREE INFORMATION CARD

7400N TTL

SN7400N	.16	SN7472N	.39	SN74160N	1.25
SN7401N	.16	SN7473N	.39	SN74161N	.99
SN7402N	.20	SN7474N	.35	SN74162N	1.95
SN7403N	.20	SN7475N	.50	SN74163N	.99
SN7404N	.20	SN7476N	.35	SN74164N	.99
SN7405N	.20	SN7479N	5.00	SN74165N	.99
SN7406N	.35	SN7480N	.50	SN74166N	1.25
SN7407N	.35	SN7482N	.99	SN74167N	3.25
SN7408N	.20	SN7483N	.70	SN74170N	2.10
SN7409N	.25	SN7485N	.89	SN74172N	8.00
SN7410N	.20	SN7486N	.39	SN74173N	1.50
SN7411N	.30	SN7488N	3.50	SN74174N	1.25
SN7412N	.35	SN7489N	2.49	SN74175N	.99
SN7413N	.69	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.75	SN74177N	.79
SN7416N	.35	SN7492N	.49	SN74179N	2.49
SN7417N	.35	SN7493N	.49	SN74180N	.99
SN7420N	.20	SN7494N	.79	SN74181N	2.49
SN7421N	.39	SN7495N	.79	SN74182N	.95
SN7422N	.49	SN7496N	.79	SN74184N	1.95
SN7423N	.37	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	1.25	SN74186N	15.00
SN7426N	.29	SN74107N	.39	SN74187N	6.00
SN7427N	.37	SN74109N	.59	SN74188N	3.95
SN7429N	.42	SN74116N	1.95	SN74190N	1.79
SN7430N	.25	SN74121N	.39	SN74191N	1.25
SN7432N	.25	SN74122N	.39	SN74192N	.89
SN7437N	.35	SN74123N	.60	SN74193N	.89
SN7438N	.35	SN74125N	.80	SN74194N	1.25
SN7439N	.25	SN74126N	.60	SN74195N	.75
SN7440N	.21	SN74132N	1.25	SN74196N	1.00
SN7441N	.89	SN74136N	.95	SN74197N	1.00
SN7442N	.69	SN74141N	1.15	SN74198N	1.75
SN7443N	.75	SN74142N	2.95	SN74199N	1.76
SN7444N	.75	SN74143N	3.25	SN74200N	5.59
SN7445N	.75	SN74144N	3.00	SN74251N	1.79
SN7446N	.89	SN74145N	1.16	SN74279N	.90
SN7447N	.69	SN74147N	2.35	SN74283N	2.25
SN7448N	.69	SN74148N	2.00	SN74284N	6.00
SN7450N	.25	SN74150N	1.25	SN74285N	6.00
SN7451N	.25	SN74151N	.79	SN74365N	.75
SN7453N	.25	SN74153N	.89	SN74366N	.75
SN7454N	.25	SN74154N	1.25	SN74367N	.76
SN7459A	.25	SN74155N	.89	SN74368N	.75
SN7460N	.25	SN74156N	.89	SN74390N	2.25
SN7470N	.45	SN74157N	.89	SN74393N	2.25

20% Discount for 100 Combined 7400's

CMOS

CD4000	.23	CD4044	.89	CD4520	1.29
CD4001	.23	CD4046	1.79	MC14562	14.50
CD4002	.23	CD4047	2.50	CD4556	2.25
CD4006	1.19	CD4048	1.35	MC14583	3.50
CD4007	.25	CD4049	.49	74C00 Series	
CD4009	.49	CD4050	.49	74C00	.39
CD4010	.49	CD4051	1.19	74C02	.55
CD4011	.23	CD4053	1.19	74C04	.75
CD4012	.25	CD4056	1.49	74C10	.65
CD4013	.39	CD4059	9.95	74C14	3.00
CD4014	1.39	CD4060	1.49	74C20	.65
CD4015	1.19	CD4066	.79	74C30	.65
CD4016	.49	CD4068	.39	74C42	2.15
CD4017	1.19	CD4069	.45	74C73	1.50
CD4018	.99	CD4070	.55	74C74	1.15
CD4019	.49	CD4071	.23	74C89	4.00
CD4020	1.19	CD4072	.49	74C90	3.00
CD4021	1.39	CD4076	1.39	74C93	2.00
CD4022	1.19	CD4081	.23	74C95	2.00
CD4023	.23	CD4082	.23	74C107	1.25
CD4024	.79	CD4098	2.49	74C151	2.90
CD4025	.23	MC14409	14.95	74C154	3.00
CD4026	2.25	MC14410	14.95	74C157	2.15
CD4027	.69	MC14411	14.95	74C160	3.25
CD4028	.89	MC14419	4.95	74C161	3.25
CD4029	1.19	MC14506	.75	74C163	3.00
CD4030	.49	MC14507	.99	74C164	3.25
CD4035	.99	CD4508	3.95	74C173	2.60
CD4040	1.19	CD4510	1.39	74C193	2.75
CD4041	1.25	CD4511	1.29	74C195	2.75
CD4042	.99	CD4515	2.95	80C95	1.50
		CD4518	1.29	80C97	1.50

LINEAR

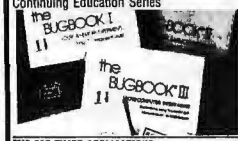
LM300H	.80	LM340T-8	1.25	LM739N	1.19
LM301H	.35	LM340T-12	1.25	LM741CH	.35
LM301CN	.35	LM340T-15	1.25	LM741CN	.35
LM302H	.75	LM340T-18	1.25	LM741-14N	.39
LM304H	1.00	LM340T-24	1.25	LM747H	.79
LM305H	.60	LM350N	1.00	LM747N	.79
LM307CN	.35	LM351CN	.65	LM748H	.39
LM308H	1.00	78MG	1.75	LM748N	.39
LM308CN	1.00	LM370N	1.15	LM1303N	.90
LM309H	1.10	LM373N	3.25	LM1304N	1.19
LM309K	1.25	LM377N	4.00	LM1305N	1.40
LM310CN	1.15	LM380N	1.25	LM1307N	.85
LM311H	.90	LM380CN	.99	LM1310N	2.95
LM311N	.90	LM381N	1.79	LM1351N	1.65
LM317K	6.50	LM382N	1.79	LM1414N	1.75
LM318CN	1.50	NE501K	8.00	LM1458CN	.59
LM319N	1.30	NE510A	6.00	LM1496N	.95
LM320K-5	1.35	NE529A	4.95	LM1556V	1.75
LM320K-5.2	1.35	NE531H	3.00	LM2111N	1.95
LM320K-12	1.35	NE536T	6.00	LM2901N	2.95
LM320K-15	1.35	NE540L	6.00	LM3053	1.50
LM320T-5	1.25	NE550N	1.30	LM3065N	.69
LM320T-5.2	1.25	NE555V	.39	LM3900N(3401)	.49
LM320T-8	1.25	NE560B	5.00	LM3905N	.89
LM320T-12	1.25	NE561B	5.00	LM3909	1.25
LM320T-15	1.25	NE562B	5.00	LM5556N	1.85
LM320T-18	1.25	NE565H	1.75	MC5558V	1.00
LM320T-24	1.25	NE565N	1.25	LM7525N	.90
LM323K-5	5.95	NE566CN	1.75	LM7534N	.75
LM324N	1.80	NE567H	1.95	8038B	4.95
LM339N	.99	NE567V	1.49	LM75450	.49
LM340K-5	1.35	LM703CN	.45	75451CN	.39
LM340K-6	1.35	LM709H	.29	75452CN	.39
LM340K-8	1.35	LM709N	.29	75453CN	.39
LM340K-12	1.35	LM710N	.79	75454CN	.39
LM340K-15	1.35	LM711N	.39	75491CN	.79
LM340K-18	1.35	LM723H	.55	75492CN	.89
LM340K-24	1.35	LM723N	.55	75494CN	.89
LM340T-5	1.25	LM733N	1.00	RC4151	5.95
LM340T-6	1.25			RC4194	5.95
				RC4195	3.25

74LS00 TTL

74LS00	.29			74LS155	1.25
74LS02	.29			74LS157	1.50
74LS03	.29			74LS160	1.95
74LS04	.35	74LS76	.49	74LS161	1.95
74LS05	.35	74LS83	1.75	74LS162	1.95
74LS08	.29	74LS85	2.49	74LS163	1.95
74LS10	.29	74LS86	.49	74LS164	1.95
74LS13	.89	74LS90	.89	74LS175	1.95
74LS14	1.75	74LS92	.89	74LS181	3.69
74LS20	.29	74LS93	.89	74LS190	2.49
74LS26	.39	74LS95	1.50	74LS191	2.49
74LS27	.39	74LS96	1.89	74LS192	2.49
74LS28	.39	74LS107	.59	74LS193	2.49
74LS30	.29	74LS109	.59	74LS194	1.89
74LS32	.39	74LS112	.59	74LS195	1.89
74LS40	.39	74LS123	1.25	74LS253	1.75
74LS42	1.25	74LS132	1.25	74LS257	1.75
74LS47	1.25	74LS136	.59	74LS260	.55
74LS51	.29	74LS138	1.25	74LS279	.79
74LS55	.29	74LS139	1.25	74LS367	.99
74LS73	.49	74LS151	1.25	74LS368	.99
74LS74	.49			74LS670	3.95

BUGBOOK®

Continuing Education Series



BUGBOOKS I and II — $17.00 per set
by Peter R. Rony, David G. Larsen, WB4HYJ
Sold as a set these two books outline over 90 experiments designed to teach the reader all he will need to know about TTL logic chips to use them in conjunction with microprocessor systems. You'll learn about the basic concepts of digital electronics including gates, flip-flops, latches, buses, decoders, multiplexers, demultiplexers, LED displays, RAM's, ROM's, and much, much more.

BUGBOOK IIa — $5.00
by Peter R. Rony, David G. Larsen, WB4HYJ
This volume will introduce you to the fabulous UART chip — that all important interface between data terminals, etc., and your microcomputer. It also covers current loops, and the RS 232C interface standard. Particularly recommended for any RTTY enthusiast.

THE 555 TIMER APPLICATIONS SOURCEBOOK WITH EXPERIMENTS — $6.95
by Howard M. Berlin
This book shows you what the 555 timer is and how to use it. Included are over 100 various design techniques, equations and graphs to create "ready-to-go" timers, generators, power supplies, measurement and control circuits, party games, circuits for the home and automobile, photography, music and Amateur Radio.

BUGBOOK III — $15.00
by Peter R. Rony, David G. Larsen, WB4HYJ, Jonathan A. Titus
Here is the book that puts it all together. Besides having much valuable text there are a series of experiments in which the reader completely explores the 8080 chip pin by pin and introduces you to the Mark 80 microcomputer, a unique easily interfaced system. It is recommended that you have the background on the BUGBOOKS I & II before proceeding with BUGBOOK III.

INSTRUCTOR'S MANUAL — $3.00
Necessary for instruction of Bugbook I and II. Answers questions regarding experiments, suggestions for further reading, philosophy of authors approach to digital electronics. A must for self-teaching individuals.

BUGBOOK V and VI — $19.00 per set
by David G. Larsen, Peter R. Rony, Jonathan A. Titus
Experiments in digital electronics, 8080A microcomputer programming and 8080A interfacing. An integrated approach to self-instructed basic digital electronics, breadboarding and 8080A interfacing/programming. Bugbook VI integrates the digital concepts of Bugbook V into a treatment of 8080A microcomputer programming and interfacing. Detail & laboratory experiments included with each book.

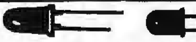
OP AMP MANUAL — $9.00
An experiment guide to application of operational amplifiers. Over 25 experiments on all phases of Op Amps.

CMOS-M — DESIGNERS PRIMER AND HANDBOOK — $6.00
Starts at basic structure of CMOS devices through integration into MSI

DBUG — $5.00
8080 interpretive debugger. A program for entering, debugging and storing assembly language programs.

COMPLETE MANUAL FOR DIGITAL CLOCKS by John Weiss and John Brooks
Familiarizes technician or hobbyist with basic theories behind digital clocks. Includes trouble shooting guides, basic characteristics of clocks, soldering techniques, clock component data sheets and construction tips. **$3.95**

DISCRETE LEDS



.125" dia.			.190" dia.		
XC209	Red	5/$1	XC111	Red	10/$1
XC209	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
XC209	Yellow	4/$1	XC111	Orange	4/$1

.200" dia			.185" dia.			.200" dia.		
XC22	Red	5/$1	XC526	Red	5/$1	XC556	Red	5/$1
XC22	Green	4/$1	XC526	Red	100/$8	XC556	Red	100/$8
XC22	Yellow	4/$1	XC526	Green	4/$1	XC556	Green	4/$1
XC22	Orange	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Orange	4/$1
						XC556	Clear	7/$1

.085" dia.
MV50 - Red - 6/$1

INFRA-RED LED
¼" x ¼" x 1/16"
Flat 5/$1.00

SALE DISPLAY LEDS SALE

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6680	Common Cathode-orange	.560	.79
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6710	Common Anode-red-D.D.	.560	.79
MAN 3	Common Cathode-red	.125	4/$1	MAN 6730	Common Anode-red ±1	.560	.79
MAN 4	Common Cathode-red	.187	1.95	MAN 6740	Common Cathode-red-D.D.	.560	.79
MAN 52	Common Anode-green	.300	1.00	MAN 6750	Common Cathode-red ±1	.560	.79
MAN 71	Common Anode-red	.300	1.25	MAN 6760	Common Anode-red	.560	.79
MAN 72	Common Anode-red	.300	.79	MAN 6780	Common Cathode-red	.560	.79
MAN 74	Common Cathode-red	.300	1.50	DL701	Common Anode-red ±1	.300	1.00
MAN 81	Common Anode-yellow	.300	.79	DL702	Common Cathode-red	.300	1.25
MAN 82	Common Anode-yellow	.300	.79	DL704	Common Cathode-red	.300	.99
MAN 84	Common Cathode-yellow	.300	.79	DL707	Common Anode-red	.300	.99
MAN 3620	Common Anode-orange	.300	.79	DL741	Common Anode-red	.600	1.49
MAN 3630	Common Anode-orange ±1	.300	1.35	DL746	Common Anode-red ±1	.630	1.95
MAN 3640	Common Cathode-orange	.300	.79	DL747	Common Anode-red	.600	1.49
MAN 4610	Common Anode-orange	.300	.79	DL749	Common Cathode-red ±1	.630	1.95
MAN 4640	Common Cathode-orange	.400	.79	DL750	Common Cathode-red	.600	1.49
MAN 4710	Common Anode-red ±1	.400	.79	DL338	Common Cathode-red	.110	3/1.00
MAN 4730	Common Anode-red	.400	1.00	FND70	Common Cathode (FND359)	.250	.69
MAN 4740	Common Cathode-red	.400	.79	FND503	Common Cathode (FND500)	.500	.99
MAN 4810	Common Anode-yellow	.400	1.00	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.79	5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
MAN 6630	Common Anode-orange	.560	.79	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6640	Common Cathode-orange-D.D.	.560	.79	5082-7304	Overrange character (±1)	.600	15.00
MAN 6650	Common Cathode-orange ±1	.560	.79	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50
MAN 6660	Common Anode-orange	.560	.79				

RCA LINEAR

CA3013	2.15	CA3082	2.00
CA3023	2.56	CA3083	1.60
CA3035	2.48	CA3086	.85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3091	3.50
CA3053	1.50	CA3102	2.95
CA3059	3.25	CA3123	2.15
CA3060	3.25	CA3130	1.39
CA3080	.85	CA3140	1.25
CA3081	2.00	CA3401	.49
		CA3600	1.75

EXAR

XR-2206KB Kit $19.95 — XR-2206KA Kit $14.95

WAVEFORM GENERATORS		MISCELLANEOUS		TIMERS	
XR-205	$8.40	XR-2211CP	$6.70	XR-555CP	$ .49
XR-2206CP	5.50	XR-4136	2.00	XR-320P	1.55
XR-2207CP	3.85	XR-1468	3.85	XR-556CP	1.85
STEREO DECODERS		XR-1488	5.80	XR-2556CP	3.20
XR-1310CP	$3.20	XR-1489	4.80	XR-2240CP	4.80
XR-1310EP	3.20	XR-2208	5.20	**PHASE LOCKED LOOPS**	
XR-1800P	3.20			XR-210	5.20
XR-2567	2.99			XR-215	6.60
				XR-567CP	1.95
				XR-567CT	1.70

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	16	15	24 pin	$.38	37	36
14 pin	20	19	18	28 pin	45	44	43
16 pin	22	21	20	36 pin	60	59	58
18 pin	29	28	27	40 pin	63	62	61
22 pin	37	36	35				

SOLDERTAIL STANDARD (TIN)

14 pin	$.27	25	24	28 pin	$.99	90	81
16 pin	.30	27	25	36 pin	1.39	1.26	1.15
18 pin	35	32	30	40 pin	1.59	1.45	1.30
24 pin	49	45	42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	27	24	24 pin	$.70	63	57
14 pin	35	32	29	28 pin	1.10	1.00	90
16 pin	38	35	32	36 pin	1.75	1.40	1.26
18 pin	52	47	43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

8 pin	$.40	.38	.35	22 pin	.95	.85	.75
10 pin	45	41	37	24 pin	$1.05	95	85
14 pin	39	38	37	28 pin	1.40	1.25	1.10
16 pin	43	42	41	36 pin	1.59	1.45	1.30
18 pin	75	68	62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	1/4 WATT 5%	50 PCS.
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	1/4 WATT 5%	50 PCS.
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	1/4 WATT 5%	50 PCS.
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	1/4 WATT 5%	50 PCS.
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	1/4 WATT 5%	50 PCS.
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	1/4 WATT 5%	50 PCS.
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	1/4 WATT 5%	50 PCS.

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
Dealer Information Available

NOW OPEN SATURDAYS

James ELECTRONICS

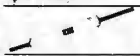
1978 CATALOG NOW AVAILABLE

1021-A HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097
Advertised Prices Good Thru April

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP
- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

$11.95



WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire **$3.45 ea.**
- Cuts wire to desired length
- Strips 1" of insulation **Specify** — Blue-Yellow-White-Red

REPLACEMENT DISPENSER SPOOLS FOR WD 30
Specify blue, yellow, white or red **$1.98/spool**

Prime Stock Inventory Clearance STEWART WARNER Special Offer

P/N	10(min.)	100	1000	P/N	10(min.)	100	1000
SW7401	$1.20/lot	$9.00/lot	$80.00/lot	SW7482	$4.90/lot	44.00/lot	430.00/lot
SW7407	2.20	19.00	180.00	SW7483	3.50	31.00	300.00
SW7416	2.20	19.00	180.00	SW7486	2.20	19.00	180.00
SW7417	2.20	19.00	180.00	SW7491	3.50	31.00	300.00
SW7420	1.30	11.00	100.00	SW7494	3.50	31.00	300.00
SW7423	2.20	19.00	180.00	SW7495	3.50	31.00	300.00
SW7425	1.70	14.00	130.00	SW7496	3.50	31.00	300.00
SW7427	1.50	12.00	110.00	SW74100	6.90	66.00	650.00
SW7430	1.50	12.00	110.00	SW74104	2.20	19.00	180.00
SW7432	1.50	12.00	110.00	SW74105	2.20	19.00	180.00
SW7437	1.50	12.00	110.00	SW74107	2.20	19.00	180.00
SW7438	1.50	12.00	110.00	SW74121	2.20	19.00	180.00
SW7440	1.20	9.00	80.00	SW74123	2.50	22.00	200.00
SW7443	3.50	31.00	300.00	SW74145	5.50	51.00	500.00
SW7444	3.50	31.00	300.00	SW74150	6.90	66.00	650.00
SW7445	3.50	31.00	300.00	SW74151	3.50	31.00	300.00
SW7446	4.00	36.00	350.00	SW74153	4.00	36.00	350.00
SW7450	1.20	9.00	80.00	SW74156	4.00	36.00	350.00
SW7453	1.20	9.00	80.00	SW74180	4.50	41.00	400.00
SW7454	1.20	9.00	80.00	SW74181	9.90	96.00	950.00
SW7460	1.20	9.00	80.00	SW74182	4.50	41.00	400.00
SW7472	2.20	19.00	180.00	SW9601	2.50	22.00	200.00
SW7475	3.50	31.00	300.00	SW9602	4.90	44.00	430.00
SW7480	2.90	26.00	250.00				

Pre-tubed • No mixing or combining prices

TV GAME CHIP SET — $7.95

Includes AY-3-8500-1 Chip and 2.010 mhz crystal
(2.010 crystal — $.99 ea/AY-3-8500-1 Chip — $7.50 ea.)

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N456	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
1N485A	180	10m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1.95

TRANSISTORS

MPS A05	30			PN4250	4/$1.00
MPS A06	5/$1.00			2N4400	4/$1.00
2N918	4/$1.00			2N4401	4/$1.00
2N2219A	3/$1.00	2N3638	5/$1.00	2N4402	4/$1.00
2N2221	4/$1.00	2N3702	5/$1.00	2N4403	4/$1.00
2N2222A	5/$1.00	2N3704	5/$1.00	2N4409	5/$1.00
2N2369	5/$1.00	2N3705	5/$1.00	2N5086	4/$1.00
2N2369A	4/$1.00	2N3706	5/$1.00	2N5087	4/$1.00
2N2484	4/$1.00	2N3707	5/$1.00	2N5088	4/$1.00
2N2906A	4/$1.00	2N3711	5/$1.00	2N5089	4/$1.00
2N2907A	5/$1.00	2N3724	$ .65	2N5129	5/$1.00
2N2925	5/$1.00	2N3725	$1.00	2N5138	5/$1.00
2N3035	2/$1.00	2N3772	$2.25	2N5139	5/$1.00
2N3055	$ .89	2N3903	5/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N3904	4/$1.00	2N5210	5/$1.00
MJE3055	$1.00	2N3905	4/$1.00	2N5432	$2.00
2N3392	5/$1.00	2N3906	4/$1.00	2N5449	3/$1.00
2N3398	5/$1.00	2N4013	3/$1.00	2N5951	5/$1.00
PN3567	3/$1.00	2N4014	3/$1.00	C106B1SCR	2/$1.00
PN3568	4/$1.00	2N4123	6/$1.00	40409	$1.75
PN3569	4/$1.00	PN4249	4/$1.00	40410	$1.75

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.13	.10	1.0/16V	.15	.13	.10
4.7/25V	.16	.14	.12	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

SOCKET JUMPERS

Mates with two rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles. Probe access holes in back. Choice of 6" or 18" length.

Part No.	No. of Contacts	Length	Price
924003-18R	26	18"	$ 5.38 ea.
924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7.33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

JUMPER HEADERS

Solder to PC boards for instant plug-in access via socket-connector jumpers. .025" sq. posts. Choice of straight or right angle.

Part No.	No. of Posts	Angle	Price
923863-R	26	straight	$1.28 ea.
923873-R	26	right angle	1.52 ea.
923865-R	40	straight	1.94 ea.
923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

INTRA-CONNECTOR

Provides both straight and right angle functions. Mates with standard .10" x .10" dual row connectors (i.e. 3m, Ainsley, etc.) Permits quick testing of inaccessible lines.

Part No.: 922576-26 No. of contacts: 26 Price $6.90 ea.

INTRA-SWITCH

Permits instant line-by-line switching for diagnostic or QA testing. Switches actuated with pencil or probe tip. Mates with standard .10" x .10" dual-row connectors. Low profile design. Switch buttons recessed to eliminate accidental switching.

Part No.: IS-26 No. of contacts: 26 Price $13.80 ea.

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1 000 MHz	HC33/U	$5.95
CY2A	2 000 MHz	HC33/U	$5.95
CY2 01	2 010 MHz	HC33/U	$ .99
CY3A	4 000 MHz	HC18 U	$4 95
CY7A	5 000 MHz	HC18 U	$4 95
CY12A	10 000 MHz	HC18 U	$4 95
CY14A	14 31818 MHz	HC18U	$4 95
CY19A	18 000 MHz	HC18 U	$4 95
CY22A	20 000 MHz	HC18 U	$4 95
CY30B	32 000 MHz	HC18 U	$4 95

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out

Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100A (.100 Spacing)	PINS (Wire Wrap)	$6.95

25 PIN-D SUBMINATURE (RS232)

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95
DB51226-1	COVER FOR 25S/25P	$1.75

LOTS OF POTS

Untested ⅜" square Spectrol Trimpots

Single-turn Printed Circuit Potentiometers

GB134	3 ea. of:	10-20-25-50 100-200-250-500 ohm	= 24 pcs.	$2.95
GB135	3 ea. of:	1K-2K-2.5K-5K 10K-20K-25K-50K	= 24 pcs.	$2.95
GB136	3 ea. of:	100K-200K-250K-500K 1Meg-2Meg-2.5Meg-5Meg	= 24 pcs.	$2.95

(Values subject to substitution within each group.)

'EXTRA SAVINGS' Buy all 3 (GB134, 135 & 136) for only $7.49

SWITCHES

¼" mounting holes

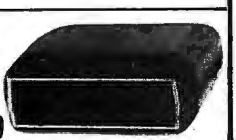
				1-9	10+
TOGGLE (sub-minature)	JMT121	SPDT	on-off-on	$1.95	$1.43
	JMT123	SPDT	on-none-on	1.65	1.21
	JMT221	DPDT	on-off-on	2.55	1.87
	JMT223	DPDT	on-none-on	2.15	1.58
TOGGLE (Printed Circuit)	MPC121	SPDT	on-off-on	$2.05	$1.53
	MPC123	SPDT	on-none-on	1 75	1.31
	MPC221	DPDT	on-off-on	2.65	1.97
	MPC223	DPDT	on-none-on	2.25	1.68
PUSH BUTTON	PB123	SPDT	maintained	1.95	1.47
	PB126	SPDT	momentary	1 95	1.47
PUSH BUTTON Minature	MS102	DPST	momentary open	.35	.30
	MS103	SPST	momentary closed	.35	.30
DIPSWITCH SPST	206-4	8 pin dip	4 switch	1.75	1.65
	206-7	14 pin dip	7 switch	1.95	1.85
	206-8	16 pin dip	8 switch	2.25	2.15

1/16 VECTOR BOARD

	0.1" Hole Spacing Part No.	P-Pattern L	W	Price 1-9	10 up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY	64P44 062WE	4.50	6.50	2.07	1.86
GLASS	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

INSTRUMENT/ CLOCK CASE

Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16".



$3.49

MICROPROCESSOR COMPONENTS

8080A	CPU	$10.95	CDP1802	CPU	$19.95
8212	8 Bit Input/Output	4.95	MC6800	8 Bit MPU	19.95
8214	Priority Interrupt Control	7.95	MC6820	Periph. Interface Adapter	7.95
8216	Bi-Directional Bus Driver	4.95	MC6810AP1	128 x 8 Static RAM	5.95
8224	Clock Generator/Driver	5.95	MC6830L8	1024 x 8 Bit ROM	15.00
8228	System Controller Bus Driver	5.95	Z80	CPU	24.95

CPU'S		
8080A	Super 8008	$10.95
2650	8 Bit MPU	26.50
P8085	CPU	29.95
SR'S		
2504	1024 Dynamic	$3.95
2518	Hex 32 BIT	7.00
2519	Hex 40 BIT	4.00
2522	Dual 132 Bit SSR	2.95
2524	512 Dynamic	.99
2525	1024 Dynamic	3.00
2527	Dual 256 BIT	3.95
2529	Dual 512 BIT	4.00
2532	Quad 80 BIT	3.95
2533	1024 Static	5.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	3.95
UART'S		
AY-5-1013	30K Baud	$5.95
ROM'S		
2513(2140)	Char Gen -upper case	$9.95
2513(3021)	Char Gen. -lower case	9.95
2516	Char. Gen	10.95
MM5230	2048 BIT (512 x 4 on 256 x 8)	1.95
MM5262	2K x 1 Dynamic RAM	3 for 1.00

RAM'S			
1101	256 x 1	Static	$1.49
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107/5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
TMS4044-45NL	4K	Static	14.95
7489	16 x 4	Static	2.49
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
21L02/91L02	1024 x 1	Static	2.25
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
UPD414(2104)	4K	Dynamic 16 Pin	5.95
UPD416	16K	Dynamic	49.95
PROMS			
1702A	2048	Famos	$5.95
5203	2048	Famos	14.95
82S23	32 x 8	Open C	5.00
82S123	32 x 8	Tristate	5.00
74S287	1024	Static	7.95
3601	256 x 4	Fast	3.95
2708	8K	Eprom	10.95
2716	16K	Eprom	29.95
6301-1	1024	Tri-State Bipolar	3.49
6330-1	256	Open Collector Bipolar	2.95

SPECIAL REQUESTED ITEMS

FCM3817	$5.00	11C90	19.95	7205	19.95	9368	3.95
AY-3-8500-1	7.50	4N33	3.95	ICM7045	24.95	LD110/111	25.00/set
AY-5-9100	17.50	8T20	7.50	ICM7207	7.50	95H90	11.95
AY-5-9200	14.95	8T97	2.00	ICM7208	22.00	MC3061P	3.50
AY-5-9500	4.95	HD0165	7.95	ICM7209	7.50	MC4016 (74416)	7.50
AY-5-2376	14.95	MCM6571	13.50	MK50240	17.50	MC1408L7	8.95
9374	1.95	MCM6574	13.50	DS0026CH	3.75	MC1408L8	9.95
82S115	25.00	MCM6575	13.50	TIL308	10.50	74C922	9.95

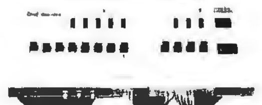
CLOCK CHIPS	
MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
CT7001	5.95

PARATRONICS

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit Model 100A

$229.00/kit



- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

(Model 100A Manual - $4.95)

- Some applications are:
  - — Troubleshooting microprocessor address, instruction, and data flow
  - — Examine contents of ROMS
  - — Tracing operation of control logic
  - — Checking counter and shift register operation
  - — Monitoring I/O sequences
  - — Verifying proper system operations during testing

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for integrated unit).

Model 10 Kit - $229.00

Baseplate — $9.95

Model 10 Manual — $4.95

B&K PRECISION — 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0 1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage ± 0-1000V/ AC Voltage 0-1000V
Freq Response 50-400 HZ
DC/AC Current: 0-100mA
Resistance 0-10 meg ohm
Size: 6 4" x 4 4" x 2"

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

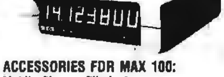
Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC — 100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1 75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95



ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95

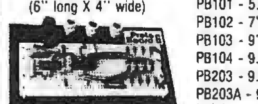
Charger/Eliminator use 110 V AC — Model 100 — CAI $9.95

CONTINENTAL SPECIALTIES

PROTO BOARD 6

$15.95

(6" long X 4" wide)



Other CS Proto Boards

PB100 - 4.5" x 6"	$ 19.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 8"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
PB203A - 9.75 x 6½ x 2¾ (includes power supply)	129.95

PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

DESIGN MATES

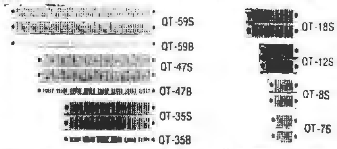
DM1 - Circuit Designer $69.95

DM2 - Function Generator $74.95

DM3 - RC Bridge $74.95

LOGIC MONITOR for DTL, HTL, TTL or CMOS Devices **$84.95**

CSC — QT PROTO STRIPS



QT type	#holes	price
QT-59S	590	12 50
QT-59B	bus strip	2 50
QT-47S	470	10 00
QT-47B	bus strip	2 25
QT-35S	350	8.50
QT-35B	bus strip	2 00
QT-18S	180	4 75
QT-12S	120	3 75
QT-8S	80	3.25
QT-7S	70	3 00

Experimentor 300	$ 9.95
Experimentor 600	$10.95

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
Dealer Information Available

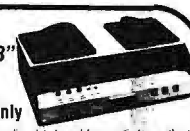
NOW OPEN SATURDAYS

James ELECTRONICS

1978 CATALOG NOW AVAILABLE

1021-A HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097
Advertised Prices Good Thru April

The Incredible "Pennywhistle 103"



$129.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications for the deaf. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.
Receive Sensitivity	−46 dbm accoustically coupled.
Transmit Level	−15 dbm nominal. Adjustable from −6 dbm to −20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

The Original the 3rd Hand

$9.95 each

- Leaves two hands free for working
- Clamps on edge of bench, table or work bench
- Position board on angle or flat position for soldering or clipping
- Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One Times Single Event — Split & Taylor
- Size 4 5" x 2 15" x 90" (4½ ounces)
- Uses 3 Penlite Cells

Kit — $39.95

Assembled — $49.95

Heavy Duty Carry Case $5.95

Stop Watch Chip Only (7205) $19.95

IMC — 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit	**$49.00**
Model 311D-5C-5V Power Kit	**$17.50**

JE700 CLOCK

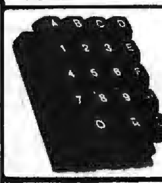
The JE700 is a low cost digital clock but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6 x 2½ x 1. It utilizes a MAN72 high brightness readout and the MM5314 clock chip

12 or 24 Hour

115 VAC

KIT ONLY **$16.95**

HEXADECIMAL ENCODER 19-KEY PAD



- 1 - 0
- ABCDEF
- Shift Key
- 2 Optional Keys

$10.95 each

New 63 KEY KEYBOARD

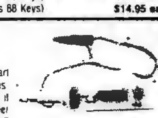
$29.95 IN STOCK

This keyboard features 63 uncoded SPST keys unattached to any kind of P C B. A very solid molded plastic 13 x 4 base suits most applications

HD0165	Encoder Chip (encodes 16 Keys)	$7.95 ea.
AY-5-2376	Encoder Chip (encodes 88 Keys)	$14.95 ea.

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL DTL RTL CMOS. It derives the power it needs to operate directly off of the circuit under test drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols (HI) - 1 (LOW) - 0 (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result



$9.95 Per Kit

printed circuit board

T²L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **$9.95 Per Kit**

S.D. COMPUTER PRODUCTS AN EMPIRE IND. CO.

P.O. BOX 28810D DALLAS, TEXAS 75228

64K FOR $995.00

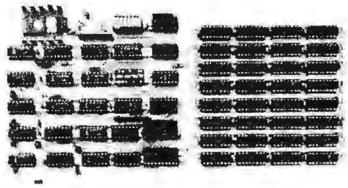
At last! The popular Expandoram is available in a 16k multiple version. Similar to our 32k Expandoram, the new Super Expandoram is offered in 16k, 32k; 48k and 64k. Low power devices mean the very lowest power consumption. Allow 3-4 weeks for delivery.

16K — $281.00	48K — $757.00
32K — $519.00	64K — $995.00

32K FOR $475 EXPANDORAM KIT 24K FOR $367.00

MEMORY CAPACITY
MEMORY ADDRESSING
MEMORY WRITE PROTECTION

8K, 16K, 24K, 32K using Mostek MK4115 with 8K boundaries and protection. Utilizes DIP switches. PC board comes with sockets for 32K operation. Orders now being accepted. Allow 6 to 8 weeks for delivery.



INTERFACE CAPABILITY
Control, data and address inputs utilizes low power Schottky devices.

POWER REQUIREMENTS
+8VDC 400MA DC
+18VDC 400MA DC
—18VDC 30MA DC

on board regulation is provided. On board (invisible) refresh is provided with no wait states or cycle stealing required.

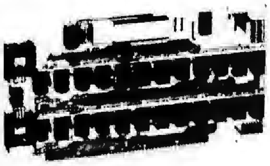
MEMORY ACCESS TIME IS 375ns.
Memory Cycle Time is 500ns.

Buy an S100 compatible 8K Ram Board and upgrade the same board to a maximum of 32K in steps of 8K at your option by merely purchasing more ram chips from S.D. Sales! At a guaranteed price — Look at the features we have built into the board.

16K FOR $259.00 8K FOR $151.00

Z-80 CPU BOARD KIT — $139.

CHECK THE ADVANCED FEATURES OF OUR Z—80 CPU BOARD Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply, always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHZ or 4MHZ operation, quality double sided plated through PC board, parts plus sockets priced for all IC's. *Add $10 extra for Z—80A chip which allows 4MHZ operation **Z—80 chip with Manual** — 29 95



S.D. SALES NEW EXPANDABLE EPROM BOARD

16K or 32K EPROM **$49.95 w/out EPROM**

Allows you to use either 2708's for 16K of Eprom or 2716's for 32K of Eprom.

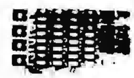
KIT FEATURES:

1. All address lines & data lines buffered.
2. Quality plated through P.C. Board, including solder mask and silk screen.
3. Selectable wait states.
4. On board regulation provided.
5. All sockets provided w/board.

WE CAN SUPPLY 450ns 2708's AT $11.95 WHEN PURCHASED WITH BOARD.

4K LOW POWER RAM KIT

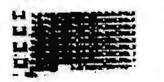
Fully Buffered — on board regulated — reduced power consumption utilizing low power 21L02 — 1 500ns RAMS — Sockets provided for all IC's Quality plated through PC board. *Add $10 for 250ns RAM operation



The Whole Works - $79.95

8K LOW POWER RAM — $159.95

Fully assembled and tested. Not a kit. Imsai — Altair — S-100 Buss compatible, uses low power static 21L02-500ns fully buffered on board regulated, quality plated through PC board, including solder mask. 8 pos. dip switches for address select.



250 ns Operation $189.95

6 DIGIT ALARM CLOCK KIT

Features: Litronix dual 1/2" displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Kit includes all necessary parts (except case). Xfmr optional. Eliminate the hassle.

AC XFMR — **$1.50 Case $3.50** **$12.95**

NEW FROM S.D. "VERSAFLOPPY"™ KIT

THE VERSATILE FLOPPY DISK CONTROLLER

ONLY $149.00

Features: IBM 3740 Soft Sectored Compatible, S-100 BNS Compatible for Z-80 or 8080. Controls up to 4 Drives (single or double sided). Directly controls the following drives:

1. Shugart SA400/450 Mini Floppy.
2. Shugart SA800/850 Standard Floppy.
3. PERSCI 70 and 277.
4. MFE 700/750.
5. CDC 9404/9406.

34 Pin Connector for Mini Floppy. 50 Pin Connector for Standard Floppy. Operates with modified CP/M operating system and C-Basic Compiler.

The new "Versafloppy" from S.D. Computer Products provides complete control for many of the available Floppy Disk Drives, Both Mini and Full Size. At the heart of "Versafloppy" is the powerful Western Digital FD1771B-1 Single Density Controller Chip. This allows a great flexibility via Control Software. Listings for Control Software are ncluded in the price.

FD 1771B-1 CHIP ALONE $39.95

Low Cost Cassette Interface Kit

Features: Play and record K.C. Standard 2400/1200 Hz tapes, 300 Baud, TTL I/O Compatible, Phase Lock Loop, Both 22 Pin Connector and 8 Pin Molex Connector. Comes partially assembled. Oscillator and phase lock loop pre-tuned to K.C. Standard. Selector switch sends cassette data or auxiliary input data to microprocessor. LED indicates logic 1 level.

$19.95

Bowmar 4 Digit LED Readout Array Full ½" Litronix Jumbo Dual Digit LED Displays

4 JUMBO .50" DIGITS ON ONE STICK! WITH COLONS & AM/PM INDICATOR

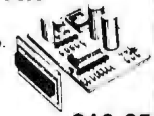
$3.95

DL 722 - C.C.	DL 728 - C.C.
DL 721 8 C.A.	DL 727 - C.A.
99c	$1.29

Jumbo LED Car Clock Kit

FEATURES:

A. Bowmar Jumbo .5 inch LED array.
B. MOSTEK — 50250 — Super clock chip.
C. On board precision crystal time base.
D. 12 or 24 hour Real Time format.
E. Perfect for cars, boats, vans, etc.
F. PC board and all parts (less case) inc.



Alarm option — $1.50
AC XFMR — $1.50

$16.95

RAMS

21L02 - 500NS	8/11 50
21L02 - 250NS	8/15 95
2114 — 4K	14 95
1101A — 256	8 $4 00
1103 — 1K	35
MK 4115 - 8K	19 45
74S 200 256	3 95

CPU's

Z—80 includes manual	29 95
Z—80A includes manual	34 95
8080A CPU 8 BIT	11 95
8008 CPU 8 BIT	6 95

PROMS

1702A - 1K - 1.5us	3.95 or 10/35.
2708 - 8K - 450ns	14.95
5204 - 4K	7.95
82S129 — 1K	2.50
2708U 8K signetics 650ns	9.95

COUNTER CHIPS

MK50397 6 Digit elapsed timer	8.95
MK50250 Alarm clock	4.99
MK50380 Alarm chip	2.95
MK50395 6 digit up/dn. count.	12.95
MK5002 4 digit counter	8.95
MK5021-Cal. chip sq. root	2.50

★ ★ ★ ★SUPER FLOPPY SPECIAL★ ★ ★ ★

S. D. SALES,' VERSAFLOPPY S-100 CONTROLLER BOARD PLUS SHUGART SA 400 FLOPPY DISK DRIVE INCLUDING CABLE FOR ONLY

$479.00

MICRO-DIP $1.95

New — Series 2300
The World's Smallest Coded BCD Dual-In-Line Switch! PC Mount

2300 02G BCD 1-2-4-8
2300 12G BCD 1-2-4-8 Compliment

★ ★ JOY STICKS ★ ★

FOUR 100 K-OHMS POTS

Ideal for electronic games

$3.95

Z-80 Programming Manual

IN DEPTH DETAIL OF THE Z-80 CPU MICRO-COMPUTER
S. D. SALES SPECIAL $9.95

Thermistors 1.5K ohm	5/$1.00
Tantalum Caps 1 mfd. 20VDC P.C. Leads	15/$1.00
Flat Pack IC Assort.	20/$1.00
Electrical Coil 13T Type C - 10T Type C	12/$1.00
2 Transistor Audio	8/$1.00
Trimmer Pots 10K, 20K, 25K, Mini	10/$1.00
Disc Caps For Bypass .01 mfg - 100 WUDC PC Leads	40/$1.00
New Cambion Jacks Part #450-4352 Gold Plated	50/$1.00

Silicon Rectifier Special 1N4007. 1 amp 1000 PN.	10/$1.00
Photocell Assortment	12/$1.00
Plastic Readout Filters Amber	6/$1.00
Disc Cap Assortment	60/$1.00
P.C. Lead Diodes 1N4148 1N 914	100/$2.00
1N4002-1A-100 PN	40/$1.00
MICA Trimmer PC402 Miniature 1.5-20 P.C. P.C. Mount	4/$1.00
Resistor Special 22 ohm Carbon Comp.	25/$1.00
Resistor Assortment 1/4 W 5% & 10% PC leads	200/$1.50

CHOOSE $1. FREE MERCHANDISE FROM ASTERISK ITEMS ON EACH $15 ORDER

MICROPROCESSOR CHIPS

8212 - I/O port	3.50
8214 — P.I.C.	12.95
8216 — Non Invert Bus	4.95
8224 — Clock Gen.	4.95
8226 — Invert Bus	3.95
PIO for Z—80	14.95
CTC for Z—80	14.95
8228 Sys. Controller	8.20
8251 Prog. comm. interfact.	10.95
8255 prog. prep. interface	13.50
8820 Dual Line Recr	1.75
8830 Dual Line Dr.	1.75
2513 Char. Gen.	7.50
8838 Quad Bus. Recvr.	2.00
74LS138N — 1/8 decoder	.99
8T97-Hex Tri-State Buffer	1.25
1488/1489 RS232	1.50
TR 1602B Uart	3.95
TR 1863 Uart	8.50
FD 1771B-1	39.95

CMOS

4001	19	4029	99
4002	19	4042	69
4011	19	4047	1.50
4013	32	4049	35
4016	32	4069	23
4017	95	4071	19
4020	97	4076	97
4022	97	14518	1.10
4024	75	14528	85
4027	39	14529	85

CALL IN YOUR BANKAMERICARD (VISA) OR MASTER CHARGE ORDER IN ON OUR CONTINENTAL TOLL FREE WATTS LINE:

1—800—527—3460

Texas Residents Call Collect:
214/271—0022

DEALER INQUIRIES INVITED!

VISA master charge

NO COD's. TEXAS RESIDENTS ADD 5% SALES TAX. ADD 5% OF ORDER FOR POSTAGE & HANDLING. ORDERS UNDER $10. ADD 75c HANDLING. FOREIGN ORDERS — U. S. FUNDS ONLY!

CIRCLE NO. 54 ON FREE INFORMATION CARD

RADIO HUT

1-800-527-2304
Use Our Toll Free Watts Line
For Master Charge and BankAmericard Orders

VISA — master charge

ELECTRONICS Market Place

VARIABLE POWER SUPPLY KIT NO. 1 ONLY $10.95

- Continuously variable from 5V to 20V
- Excellent regulation up to ½ Amp
- Kit includes all components
- Drilled fiberglass P.C. Board
- Case included
- 4400 Mfd of filtering
- One hour assembly

VARIABLE POWER SUPPLY KIT NO. 2

Same as above but with a 1 Amp output, also with case
ONLY $13.95

This model will power a 5 watt transistorized CB Radio

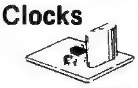
LOOK AT THIS SPECIAL FROM RADIO HUT

- Power Supply Kit: 5V1 amp reg.
- Line regulation .005%
- Load regulation 50mV

Kit includes components, PC board, transformer, fuse and pilot light. Line cord not included.

Only $6.50

60 Hz. Crystal Time Base for Digital Clocks

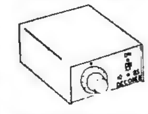


$4.50
Buy 2 for $8.

- A 60 Hz. output with accuracy comparable to a digital watch
- B Directly interfaces with all MOS clock chips.
- C Super low power consumption (1.5 ma type.)
- D Uses latest MOS 17 stage divider IC.
- E Eliminates forever the problem of AC line glitches.
- F Perfect for cars, boats, campers, or even for portable clocks at ham field days
- G Small size, can be used in existing enclosures.

KIT INCLUDES CRYSTAL, DIVIDER IC, P.C. BOARD PLUS ALL NECESSARY PARTS & SPECS.

UNSCRAMBLER



$19.95

Plugs into earphone or external speaker of any Scanner or Monitor. Guaranteed to unscramble any 1085 call.

- Easily tuned
- Full instruction included
- Drilled fiberglass P.C. Board
- One Hour Assembly
- Punched Case

7400 TTL DIGITAL CIRCUITS

7400	.11	7430	.13	7480	.31	74153	61
7401	.13	7432	.23	7481	.55	74154	.98
7402	.13	7433	.26	7482	.57	74155	.89
7403	.13	7437	.23	7483	.67	74156	89
7404	.15	7438	23	7485	.89	74157	55
74L04	.29	7440	.13	7489	1.25	74160	.55
74S04	.44	7441	.76	7490	.65	74161	65
7405	.13	7442	47	7491	61	74163	.65
7406	16	7443	59	7492	43	74164	85
7407	16	7444	.59	7493	43	74165	89
7408	19	7446	68	7494	67	74174	85
7409	19	7447	.68	7495	.67	74175	85
7410	.13	7448	71	7496	.67	74180	67
7411	18	7450	.13	74100	.30	74181	1 93
7412	.26	7451	.13	74104	.49	74182	.68
7413	.37	7453	.13	74107	.28	74191	98
7416	.15	7454	13	74109	.31	74192	79
7420	.13	7460	.19	74121	.29	74193	.81
7421	.13	7470	.27	74123	48	74194	81
7423	.25	7472	.25	74132	.99	74195	69
7425	.29	7473	.29	74136	.99	9316	.85
7426	.24	7474	.29	745138	1.95	9601	3/$1
7427	.19	7475	.47	74141	.75	9L04	.35
7428	.26	7476	31	74151	.61		

74LS00 LOW POWER SCHOTTKY

74LS00	.21	74LS47	.73	74LS136	.37	74LS258	.71
74LS02	.21	74LS51	.26	74LS138	.71	74LS260	.26
74LS03	.21	74LS54	.26	74LS139	.71	74LS266	.26
74LS04	.28	74LS55	.26	74LS145	1.00	74LS279	55
74LS05	.28	74LS73	.35	74LS151	.70	74LS290	.75
74LS08	.21	74LS74	.35	74LS153	.70	74LS293	.61
74LS09	.28	74LS76	.49	74LS155	.69	74LS295	95
74LS10	.21	74LS83	.73	74LS156	.70	74LS298	.95
74LS11	.21	74LS85	1.35	74LS157	.75	74LS365	.55
74LS13	.45	74LS86	.36	74LS158	.71	74LS366	55
74LS14	.99	74LS90	.55	74LS160	.85	74LS367	.55
74LS15	.26	74LS92	.55	74LS161	.85	74LS368	.55
74LS20	.24	74LS93	.55	74LS162	.85	74LS390	1.75
74LS21	.28	74LS109	.38	74LS163	.85	74LS393	1.45
74LS22	.28	74LS112	.38	74LS164	1.49	74LS670	2.30
74LS26	.32	74LS113	.38	74LS168	.85	74LS192	.95
74LS27	.32	74LS114	.38	74LS189	.85	74LS193	.95
74LS30	.26	74LS122	.49	74LS170	1.69	74LS194	.95
74LS32	.32	74LS124	.99	74LS173	1.10	74LS195	.85
74LS37	.32	74LS125	.47	74LS174	1.00	74LS196	.85
74LS38	.32	74LS126	.47	74LS175	.81	74LS197	.85
74LS40	.26	74LS132	.79	74LS190	.95	74LS251	.85
74LS42	.65	74LS133	.35	74LS191	.95	74LS253	.81
						74LS257	.71

74H SERIES TTL

74H00	.18	74H21	.29	74H53	.29	74H73	.39
74H05	.29	74H40	.29	74H61	.25	74H74	.39
74H20	.29	74H50	.20	74H72	.45		

CMOS

CD400	.19	CD4017	.95	CD4040	1.00	CD4071	.19
CD4001	.19	CD4018	.95	CD4041	.89	CD4081	19
CD4002	.19	CD4019	.19	CD4042	.69	CD4507	.35
CD4006	1.20	CD4020	.97	CD4043	.60	CD4508	2.80
CD4007	.19	CD4021	.97	CD4044	.60	CD4510	1.00
CD4009	.47	CD4022	.97	CD4046	1.39	CD4512	1.10
CD4010	.39	CD4023	.19	CD4047	1.50	CD4516	79
CD4011	.19	CD4024	.75	CD4049	.35	CD4518	1 10
CD4012	.29	CD4025	.19	CD4050	.39	CD4520	.69
CD4013	.32	CD4027	.39	CD4051	1 19	CD4528	.85
CD4014	78	CD4028	.85	CD4053	1.19	74C02	45
CD4015	78	CD4029	.99	CD4056	1.15	74C04	32
CD4016	32	CD4030	.35	CD4066	.78	74C107	.79

TTL SPECIAL!

9002/7400	10/1.00
9003/7410	10/1.00
9004/7420	10/1.00
9006/7460	6/1.00
9007/7430	10/1.00
9009/7440	10/1.00
9016/7404	8/1.00
9024/74109	3/1.00
9300/74195	3/1.00

9000 series parts prime from ITT. Pin for Pin compatible with 7400 series.

DTL

932	Dual 4 Input Buffer	8/$1
934	Dual 5 Input NAND Gate	10/$1
941	One Shot Multivibrator	5/$1
945	JK F/F	8/$1
946	Quad 11 Input Gate NAND/NOR	8/$1
948	JK F/F	8/$1
950	F/F	10/$1
951	One Shot Multivibrator	5/$1
1800	(see 934 above)	10/$1
1806	Quad 2 Input NAND Gate	10/$1
9093	Dual JK F/F	8/$1
9094	Dual JK F/F	8/$1
9097	Dual JK F/F	8/$1
9099	Dual JK F/F	8/$1
9109	Hex Inverter	7/$1
9110	Hex Inverter	7/$1
9112	Hex Inverter	7/$1
9601	One Shot	3/$1
9930	Dual 4 Input Ext. NAND	8/$1
9932	Quad 2 Input NAND Buffer	8/$1
9945	RS F/F	8/$1
9946	Quad 2 Input NAND	8/$1
9949	Quad 2 Input NAND	8/$1
9951	Monostable Multivibrator	8/$1
9962	Triple 3 Input NAND	8/$1

ITT HIGH LEVEL LOGIC

301	Dual 5 Input NAND Gate	15
302	Quad 2 Input Buffer open collector	18
303	Quad 2 Input NAND Buffer	15
311	Master Slave F/F	18
312	Dual JK Flip Flop	18
321	Quad 2 Input NAND Gate	18
322	Dual 5 Input NAND Gate	.15
323	Quad 2 Input NAND Gate	.18
324	Quad 2 Input NAND Gate	18
325	Dual 2 Dual 3 Input NAND Gate	.13
326	Dual 2 Dual 3 Input NAND Gate	.13
331	Dual 5 Input Expander	.13
332	Hex Inverter	.18
333	Hex Inverter	.18
334	Hex Inverter	.18
335	Hex Inverter	.18
342	Dual One Shot Multivibrator	.25
343	Dual 4 Bit Comparator	.22
370	Quad D Flip Flop	.22
371	Decode Counter	.30
372	Quad Ripple Counter	.39
380	BCE to Decimal Decoder	.39
381	BCD to Decimal Decoder	.39

ITT LED DRIVERS

ITT 501 Quad Seg. Dr.	35
ITT 502 Hex Digit Dr.	.49
ITT 503 Quad Seg Dr.	.49
ITT 506 Hex Digit Dr	49
ITT 508 8 Digit Dr	49
ITT 509 8 Seg Dr	49
ITT 511 Quad Seg Dr.	55
ITT 514 8 Digit Dr	59

We have 100's of thousands of listed parts. These parts are 100% prime

DIODES

IN 4002 1 Amp 100 PIV	40/$1
IN 4004 1 Amp 400V	15/$1
IN 4007 1 Amp 1000V	10/$1

GERMANIUM DIODES

IN 54A	$8/$1
IN 270	10/$1

ZENER DIODES

IN 746 3.3V 400M	4/$1
IN 752 5.6V 400M	4/$1
IN 1958 8.2V 400M	4/$1
IN 5259 39V 500M	10/$1
IN 5271 100V 500M	10/$1
IN 5280 180V 500M	10/$1

HOUSE # ZENER

4.7V 500 MW	10/$1
9. V 500 MW	10/$1
10V 1 Watt	8/$1
15V 500 MW	10/$1
22V 5 Watt	6/$1

SWITCHING DIODES

IN 4148/IN914 Long Leads	20/$1
IN 4148/IN914 Cut Leads	40/$1
IN 4148/IN914 PC Leads	100/$2

IMSAI SPECIAL

S-100 Connector

$3.95 Ea.

BRIDGE RECTIFIERS

1 Amp 200V	6/$1
6 Amp 50V	1.10
10 Amp 50V	1.25
25 Amp 50V	1.39

SOCKETS

• 8 Pin Low Profile	20
• 14 Pin Low Profile	22
• 16 Pin Low Profile	25
• 18 Pin Low Profile	30
• 28 Pin Low Profile	69
• 40 Pin Low profile	89

HOUSE # TTL IC's

7400	10/1.00	7437	6/1.00
7404	10/1.00	7438	6/1.00
7408	10/1.00	74141	3/1.00
7420	10/1.00	74153	3/1.00

Please specify that you are ordering House Number TTL.

CRYSTALS

300 KHz	$1.50
3.57945	1.25

COUNTER AND CLOCK CHIPS

MK50252	Clock Chip	$4.99
MM5316	Clock Chip	3.75
MK50250	Alarm Clock	3.75
MK50380	Alarm Chip	2.95
FCM7010	Direct Drive Clock Chip	4.95
MK5005	4 Digit Counter w/Latch	8.50
MK5002	4 Digit Counter	8.95
MK50395	6 Digit UP/Down Counter	12.95
MK50397	6 Digit Elapsed Timer	8.95
CT5005	Calculator Chip w/Specs	1.25
MK5021	Cal Chip w/sq. rt.	2.50

SOCKET SPECIAL! 28 PIN IC SOCKET 3 FOR $1 WHEN PURCHASED W/CLOCK IC

TRANSISTORS

INTERSIL DUAL TRANSISTORS
Originally Cost $3. each
Similar to 2N913
2 Per Pack 2/$1

GENERAL PURPOSE

2N 2905 PNP	4 $1
2N 3904 NPN	8/$1
2N 3906 PNP	8/$1
2N 3392 Pre-Amp	25/$1
2N 4400 NPN	10/$1
2N 4402 PNP	10/$1
EN 2222 NPN	8/$1
EN 2907 PNP	8/$1

POWER TRAN.

115 W 200V	NPN	95
TIP 29 (EP967)	NPN	4/$1
TIP 30 (EP929)	PNP	4 $1
TIP 31 P C Leads	NPN	5 $1
MJE 2370		3 $1
2N 3055		75
TN 2021 By RCA		95
FET TIS 75 HOUSE #		5/$1

CAPACITORS

ELECTROLYTIC

AXIAL TYPE

20 MFD	250V	5/$1
35 MFD	25V	15/$1
200 MFD	25V	5/$1
470 MFD	35V	4/$1
470 MFD	16V	4/$1
500 MFD	35V	5/$1
2000 MFD	16V	3/$1

RADIAL TYPE

47 MFD	35V PC Leads	10/$1
68 MFD	25V PC Leads	8/$1
330 MFD	50V PC Leads	5/$1
470 MFD	16V	4/$1
1000 MFD	35V PC Leads	4/$1

130 PFD MICA 5% 10/$1

COMPUTER GRADE

1,900 MFD 35WVDC (Mini)	3/$2
8,000 MFD 15WVDC	95 cents each
33,000 MFD 40WVDC	$4.00 Each

CERAMIC DISC

68 PFd 50V		680 PFd	50V
100 PFd 100V		.001 Fd	
150 PFd 50V		.002 MFd	50V
220 PFd 50V		.01 MFd	200V
330 PFd 50V		.02 MFd	200V
.001 UFd500V		3.3 PF	500V
.0015 UFd500V		4.7 PF	500V
.005 UFd500V		8.2 PF	500V
		100PF	500V

PC Leads 25/89 cents No Mix

TANTALUM

1 MFD20 WVDCPC Leads	15/$1
3.3 MFD35 WVDC PC Leads	8/$1
4 7 MFD10 WVDC PC Leads	5/$1
10 MFD20 WVDC PC Leads	8/$1
33 MFD10 WVDC	6/$1
22 UF10	10/$1

RTL's BY FAIRCHILD

The most popular digital IC's ever produced Very hard to find!

UL	DUAL 2 INPUT NOR	99
UL923	JK FLIP FLOP	$1 19

VOLTAGE REGULATORS

7805 Pos.	5V 1 Amp	.99		7818 Pos.	18V 1 Amp	.99	
7806 Pos.	8V 1 Amp	.99		7824 Pos.	24V 1 Amp	.99	
7808 Pos.	8V 1 Amp	.99		7905 Neg.	5V 1 Amp	1.10	
7812 Pos.	12V 1 Amp	.99		7912 Neg.	12V 1 Amp	1.10	
7815 Pos.	15V 1 Amp	.99		7915 Neg.	15V 1 Amp	1.10	

723 VOLTAGE REGULATORS

Output voltages variable from 2 volts to 37 volts. A very versatile and popular device.—14 PIN DIP.
69c

MOTOROLA VOLTAGE REGULATOR

MC1469R. TO-66. 9 lead package for 3 to 30V outputs. Provides 600 MA direct output or more by using an external power transistor. Regular catalog price — $4.00 each! With specs. $1.95 each

★ ★ ★ ★ ★ ★ ★ ★ ★

MUSICAL HORN

One tune supplied with each kit. Additional tunes — $6.95 each. Special tunes available. Standard tunes now available: — Dixie — Eyes of Texas — On Wisconsin — Yankee Doodle Dandy — Notre Dame — Pink Panther — Aggie War Song — Anchors Away — Never on Sunday — Yellow Rose of Texas — Deep in the Heart of Texas — Boomer Sooner — Bridge over River Kwai.

CAR & BOAT KIT $34.95 — HOME KIT $26.90 — Special Design Case $3.50

★ ★ ★ ★ ★ ★ ★ ★ ★

LINEARS

709	Operational Amplifier	.25	LM 377	Dual 2W Amplifier	1.85
710	Differential Comparators	.40	LM 3900	Quad Op-Amplifier	.40
711	Dual Differential Comp	.35	LM 741	Operational Amplifier	.25
712	Half Adder	.25	LM 748	Operational Amplifier	25
749	Stereo Pre-Amp by Fairchild	2/$1	NE 553	Quad Timer	1.95
LM 301	Operational Amplifier	.30	NE 555	Timer	40
LM 307	Operational Amplifier	.30	NE 556	Dual Timer	95
LM 308	Operational Amplifier	.95	NE 567	Tone Decoder	1.25
LM 309K	5V Lamp Regulator	1.49	1458	Dual Op-Amplifier	.55
LM 710	Voltage Comparator	25.	75491	Quad Segment Driver	.35
LM 311	Voltage Comparator	85	75492	Hex Digit Driver	.35
LM 318	Operational Amplifier	1 15	3043	IF Amplifier	.75
LM 723	Voltage Comparator	69	8038	Voltage Cont Osc	3.95
LM 324	Quad Operational Amplifier				

UNMARKED 1702A EPROMS

3.50 Ea. or 10/$32.00

LIMITED SUPPLY

12V 1 AMP POWER SUPPLY

INPUT VOLTAGE 25V MAX. OUTPUT CURRENT 1 AMP. MAX. LOAD REGULATION 50mV. OUTPUT VOLTAGE 12V. LINE REGULATION 0.01%. KIT CONTAINS ALL PARTS EXCEPT FOR LINE CORD AND TRANSFORMER.

ONLY $4.50

TELEPHONE RELAY

Assembled & Tested **$29.95**

SURREPTITIOUS INTERCEPTION OF TELEPHONE CONVERSATION IS A VIOLATION OF FEDERAL LAW AND THIS DEVICE IS NOT DESIGNED NOR INTENDED FOR SUCH USE.

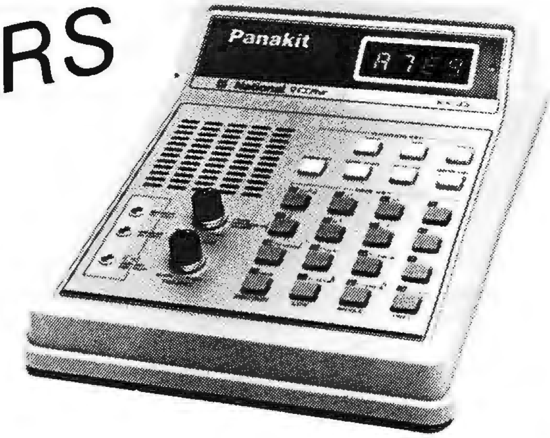
RADIO HUT

(All prices subject to change without prior notice.)
P.O. BOX 38323D
DALLAS, TEXAS 75238
AN EMPIRE IND. CO.

Money back guarantee. NO COD'S. Texas residents add 5% sales tax. Add 5% of order for postage and handling. Orders under $15.00 add 75 cents. Foreign orders add 20% for postage.
For your convenience, call your Bank Americard or Master Charge orders in on our Toll Free Watts Line: 1-800-527-2304. Texas residents call collect: 1-214-271-8423.

CIRCLE NO. 53 ON FREE INFORMATION CARD

LEARN MicroCOMPUTERS



- Easy to use.
- Teaches basic concepts of microprocessor technology.
- Easily enter and display your instructions through convenient Hex keyboard and LED readouts.
- Plays music over 3 octave range using your instructions for pitch and length of notes.
- Built-in audio amplifier with volume and tempo controls and speaker.
- Can perform control tasks over 24 hour period using built-in real time clock.
- Combine your instructions with input signals from any of 3 input sensors supplied with unit.
- Enjoy simulating various sounds, playing games and much more . . .

An easy-to-use MICROCOMPUTER, the KX-33B is built around the Panasonic 4-bit microprocessor. In addition to the arithmetic logic unit, the chip includes 1024 words by 8 bits of read-only memory for the system program and 64 words by 4 bits of random-access memory which stores keyboard data. Also in the KX-33B are two static RAM chips with 256 words of 4 bits each, which hold the tunes keyed in by the user. It also includes an 8-bit latch, audio amplifier and multivibrator IC's and a speaker. Three transducers, furnished with the unit, supply input signals; a cadium-sulfide photocell, a transducer that responds to moisture and a reed switch that closes when a magnet is near. The KX-33B operates on standard 110 Vac, 60 Hz power.

KX-33B Micro COMPUTER

Completely assembled and ready to use — including 3 input transducers **$229.00**

CLIP AND MAIL WITH ORDER

Number of units ________ @$229 ea. $________

Sales tax (Calif. only) $________

Shipping and handling $ 2.00

TOTAL $________

NAME ____________________

ADDRESS ____________________

CITY ____________ STATE ______ ZIP ______

ALLOW 30 TO 60 DAYS FOR DELIVERY

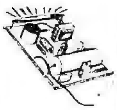
DEALER INQUIRIES INVITED

EEP ENERGY ELECTRONIC PRODUCTS

6060 MANCHESTER AVENUE, LOS ANGELES, CALIFORNIA 90045
PHONE (213) 670-7880 TWX (910) 328-6161 TELEX 696397

Electronic Warning Flasher Kit

This battery operated device continuously emits bursts of intense light. Great safety device for bicycle riders, skiers, hikers, boaters & campers. Comes complete w/ all electronic parts, quality glass-epoxy P-C board & easy to understand instructions. Uses high-output xenon flash tube which flashes 2 times per second when batteries are fresh. Operates continuously for 12 hours on 2 alkaline "C" batteries. You need only to supply the batteries and, if desired, a battery holder & case.



C23207 $6.95 (3 for $18.00)

Strobe Light Kit — COMPLETE variable-rate strobe light kit. Contains all parts, including line cord, PC board and instructions. Operates on 117 VAC. $7.50 each

6 KV TRIGGER COILS 2 for $1 — required to "fire" xenon flash tubes.

Green Neon — Same as NE2 but glows GREEN. Operates on 120V. 6 for $1.00

NEW LIQUID CRYSTAL WATCH DISPLAY WITH SPECS. $1.25 — MOTOROLA MLC500

SLIDE SWITCH ASSORTMENT 20 for $1.00

MV109 TUNING DIODE 2 for $1.00

LASCR 200 VOLT .3 AMP. C23063 4 for $1.00

MICRO-MINIATURE ROTARY SWITCH 1 POLE, 8 POSITION 79¢

HONEYWELL STROBE 14" SHUTTER CORD $1.00

Electronic Flash Unit

Guide no. 28 ASA 25.

SALE — These were to be installed in cases but the final assembly was never completed. You get a complete working flash unit. Operates on 2 AA penlight batteries. You need only supply a shutter cord, battery holder & batteries, & if desired, some sort of case. Appx. overall size of circuit board, reflector & capacitor: 3" x 2½" x 1½".

$3.95 C22867

PHOTOFLASH CAPS

350 mf 330V 1.00
720 mf 360V 1.50
520 mf 500V 2.00

REFLECTOR — Metal matte finish round reflector for electronic flash, strobes, slave lights, etc. 3-3/4" Dia. x 1-7/8" — $ 2.00

STROBE TUBE ASST. — Brand new factory prime strobe tubes. Assortment of 5 strobe tubes, w/ schematics. C23280 $ 2.00

5V REED RELAY SPST $1.00
5V REED RELAY SPDT 1.50
JUMBO YELLOW LED 5/$1.00
78L05 5V REG. 5/$1.00
400V 8AMP SCR (USED) 3/$1.00

CHANEY electronics

- Minimum order $5.00
- Please include $1 for postage
- Visa, MC and COD accepted.
- Phone orders are welcome.

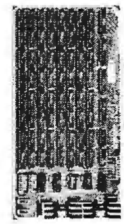
P.O. BOX 27038, DENVER, CO. 80227 Ph: (303) 973-1052

Send for our FREE GIANT CATALOG of unique items !!!

CIRCLE NO. 12 ON FREE INFORMATION CARD

8K ECONORAM II™: kit $135, 3 kits for $375, assembled and tested $155.

This is the board that thousands of owners swear on, not at. There are lots of reasons, such as unique addressing options, reliability, full buffering, fast access time, a full set of sockets . . . but probably the most popular feature is the price, which is all the more remarkable because of the high level of quality. One owner reviewed this board in the 1/77 issue of *Kilobaud*, closing with the words "If you're not convinced by now that the Econoram II is one of the best memory buys on the market today, you really have to be one tough cookie—either that or you work for someone else who makes memory boards."



12K ECONORAM VI™: $235

We proudly welcome our newest memory board family member, designed from the ground up for full compatibility with the Heath Company H8. Organized as two independent blocks, one 8K block and one 4K. Has the same basic features as our ECONORAM II™—all static design, switch selected protect and phantom, sockets for all ICs, full buffering—plus the required hardware and edge connector to mate mechanically with the H8. You can have our 12K board for the price of the Heath Company's 8K . . with the performance you have come to expect from products carrying the ECONORAM trade mark.

MORE COMPUTER ITEMS

"8K X 8 ECONORAM III™" Dynamic memories have a reputation for low power, economy — and difficulty of use. If you'd like to have the good without the bad, then this is the board for you. Not a kit; comes assembled, tested, and ready to run in any S-100 machine (Altair, IMSAI, etc.). Configuration as two separate 4K blocks. Zero wait states with 8080 CPU. 1 year warranty. **$149.00**

"Vector #8803 Bare 10 Slot Motherboard" This is a version of our 10 slot motherboard, but contains no edge connectors, active termination circuitry, or other components — just the board. Great for experimenters or people with small systems who don't need the full kit. **$29.50**

10 SLOT MOTHERBOARD $90
18 SLOT MOTHERBOARD $124
These S-100 buss motherboards come with edge connectors and active termination circuitry.

We got our start in this business selling components to enthusiastic hobbyists who couldn't find the parts of their dreams anywhere else. What with all the attention being lavished on our computer kits, music kits, and hobby kits, we wanted to take this opportunity to remind you that we still sell parts . . . at the same outrageously low prices that got us going in the first place.

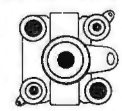
Need some resistors? Capacitors? Or maybe some ICs . . . CMOS . . . linears . . memories . . . Vector products (like the Slit-N-Wrap or wire pencil) . . . or a really classy chassis to dress up your next project . . . we've got all that, and then some.

A Message:

Now you can have the quality of Godbout products and the convenience of local shopping . . . many computer stores and other electronic outlets stock a number of our items, from individual components to complete board kits.

We always welcome new dealers; if you have a store and want to know more about adding these popular products to your line, write or phone and ask for our dealer package.

Finally, we'd like to add that even inveterate optimists such as ourselves have been amazed and delighted at the response to our computer kits. We thank you very much for your support (and your patience during our period of heaviest expansion); it will enable us to keep you excited with more new goodies in the months ahead.



How about an American made, **Switchcraft RCA phono jack**? (Closed circuit too — that's a rare bird). Comes mounted on a little plastic carrier with screw holes for easy mounting. At **7 for $1**, here is a chance to stock up on some top quality connectors.

Send for our flyer

Terms: Cal res add tax. Allow 5% shipping; excess refunded. Masterchange® /VISA® orders ($15 min) call **(415) 562-0636**, 24 hrs. COD OK with street address.

GODBOUT
BILL GODBOUT ELECTRONICS
BOX 2355, OAKLAND AIRPORT, CA 94614

CIRCLE NO. 27 ON FREE INFORMATION CARD

74Cxx SERIES PRICES REDUCED UP TO 72 PERCENT

Thanks to a major contract that we just concluded, and in our effort to bring you the lowest possible prices, this month we have reduced our prices on every device in the 74Cxx Series, and for some items by as much as 72%! Of course, as always, we guarantee that every item we sell to be of Prime, First Run quality with full manufacturer's markings.

74xx TTL

7400	$0.14	7472	0.24	74167	3.20	74LS11	0.21
7401	0.15	7473	0.24	74170	1.85	74LS12	0.27
7402	0.15	7474	0.24	74173	1.10	74LS13	0.40
7403	0.15	7475	0.45	74174	0.85	74LS14	0.85
7404	0.16	7476	0.29	74175	0.75	74LS15	0.26
7405	0.16	7480	0.31	74176	0.69	74LS20	0.23
7406	0.24	7482	0.50	74177	0.70	74LS21	0.23
7407	0.24	7483	0.54	74178	1.20	74LS22	0.23
7408	0.17	7485	0.80	74179	1.20	74LS26	0.31
7409	0.17	7486	0.27	74180	0.65	74LS27	0.26
7410	0.15	7489	1.75	74181	1.75	74LS30	0.23
7411	0.18	7490	0.40	74182	0.75	74LS32	0.30
7412	0.20	7491	0.51	74184	1.75	74LS37	0.31
7413	0.25	7492	0.40	74185	1.75	74LS38	0.31
7414	0.55	7493	0.40	74188	2.80	74LS40	0.26
7416	0.22	7494	0.60	74190	0.95	74LS42	0.60
7417	0.22	7495	0.60	74191	0.95	74LS47	0.75
7420	0.15	7496	0.60	74192	0.80	74LS48	0.72
7421	0.17	7497	2.45	74193	0.80	74LS51	0.25
7423	0.25	74107	0.29	74194	0.80	74LS54	0.25
7425	0.25	74109	0.32	74195	0.49	74LS55	0.25
7426	0.22	74121	0.29	74196	0.73	74LS73	0.38
7427	0.19	74122	0.35	74197	0.73	74LS74	0.35
7430	0.15	74123	0.39	74198	1.30	74LS76	0.37
7432	0.23	74125	0.37	74199	1.30	74LS78	0.36
7437	0.21	74126	0.38	74251	1.00	74LS83	0.75
7438	0.21	74132	0.65	74279	0.49	74LS85	1.30
7439	0.25	74141	0.70	74283	1.00	74LS86	0.36
7440	0.15	74145	0.65	74290	0.59	74LS90	0.50
7441	0.70	74147	1.50	74293	0.57	74LS92	0.50
7442	0.38	74148	1.15	74298	0.92	74LS93	0.50
7443	0.55	74150	0.79	74365	0.62	74LS95	0.85
7444	0.55	74151	0.59	74366	0.62	74LS107	0.35
7445	0.55	74152	0.59	74367	0.62	74LS109	0.35
7446	0.62	74153	0.60	74368	0.62	74LS112	0.35
7447	0.57	74154	0.95	**74LSxx TTL**		74LS113	0.35
7448	0.60	74155	0.65	74LS00	$0.21	74LS114	0.35
7450	0.15	74156	0.65	74LS01	0.27	74LS123	0.90
7451	0.15	74157	0.59	74LS02	0.21	74LS125	0.46
7453	0.15	74158	0.59	74LS03	0.21	74LS126	0.46
7454	0.15	74160	0.79	74LS04	0.24	74LS132	0.72
7459	0.15	74161	0.79	74LS05	0.24	74LS133	0.34
7460	0.15	74162	0.79	74LS08	0.23	74LS136	0.35
7470	0.27	74163	0.79	74LS09	0.23	74LS138	0.70
		74164	0.79	74LS10	0.21	74LS139	0.70
		74165	0.90			74LS151	0.65
		74166	0.95			74LS152	0.65

74LS153	0.66	74LS670	2.29	74S257	1.15	74C162	1.08
74LS154	1.00	**74Sxx TTL**		74S258	1.15	74C163	1.08
74LS155	0.62	74S00	$0.35	74S280	2.25	74C164	1.08
74LS156	0.62	74S02	0.35	74S287	3.20	74C165	1.08
74LS157	0.62	74S03	0.35	74S289	3.55	74C173	1.16
74LS158	0.70	74S04	0.36	74S300	1.60	74C174	1.08
74LS160	0.82	74S05	0.36	74S305	1.90	74C175	1.04
74LS161	0.82	74S08	0.38	74S310	2.85	74C192	1.30
74LS162	0.82	74S09	0.38	74S312	1.05	74C193	1.30
74LS163	0.82	74S10	0.35	74S313	1.55	74C195	1.10
74LS164	0.98	74S11	0.38	74S316	2.80	74C200	7.50
74LS168	0.83	74S15	0.38	74S341	4.10	74C221	1.38
74LS169	0.83	74S20	0.35	74S342	1.20	74C901	0.48
74LS170	1.60	74S22	0.36	74S343	4.95	74C902	0.48
74LS173	1.00	74S30	0.27	74S346	1.25	74C903	0.48
74LS174	0.75	74S32	0.50	74S362	2.15	74C904	0.48
74LS175	0.79	74S40	0.35	74S387	4.70	74C905	6.00
74LS181	2.50	74S51	0.17	**74Cxx TTL**		74C906	0.48
74LS190	0.90	74S60	0.35	74C00	$0.24	74C907	0.48
74LS191	0.90	74S64	0.38	74C02	0.24	74C908	0.96
74LS192	0.90	74S65	0.38	74C04	0.26	74C909	1.78
74LS193	0.90	74S74	0.58	74C08	0.25	74C910	6.00
74LS194	0.85	74S76	0.58	74C10	0.24	74C914	0.90
74LS195	0.50	74S78	0.58	74C14	0.90	74C918	1.16
74LS196	0.80	74S112	0.58	74C20	0.25	74C925	7.80
74LS197	0.80	74S113	0.58	74C30	0.24	74C926	7.80
74LS221	1.05	74S114	0.58	74C32	0.25	74C927	7.80
74LS251	0.80	74S132	0.75	74C42	0.94	74C928	7.80
74LS253	0.80	74S133	0.38	74C48	0.96		
74LS257	0.70	74S134	0.38	74C73	0.62		
74LS258	0.70	74S135	0.49	74C74	0.48		
74LS259	1.60	74S138	0.77	74C76	0.68		
74LS260	0.34	74S139	1.50	74C83	1.28		
74LS266	0.26	74S140	0.47	74C85	1.20		
74LS279	0.52	74S151	1.25	74C86	0.40		
74LS283	0.72	74S153	2.10	74C89	3.95		
74LS290	0.60	74S157	0.75	74C90	0.92		
74LS295	0.90	74S158	1.25	74C93	0.92		
74LS298	0.90	74S174	1.50	74C95	1.04		
74LS365	0.52	74S175	1.45	74C107	0.68		
74LS366	0.52	74S189	2.75	74C151	1.78		
74LS367	0.52	74S194	1.75	74C154	2.90		
74LS368	0.52	74S200	3.25	74C157	1.78		
74LS386	0.36	74S206	3.75	74C160	1.08		
74LS390	1.65	74S253	0.95	74C161	1.08		
74LS393	1.35						
74LS490	1.10						

VOLUME DISCOUNT SCHEDULE

Merchandise Total	Discount
$ 0.00–$ 9.99	NET
$ 10.00–$ 24.99	LESS 5%
$ 25.00–$ 99.99	LESS 10%
$ 100.00–$499.99	LESS 15%
$ 500.00–$999.99	LESS 20%
$1000.00 and Up	LESS 25%

STANDARD SHIPPING CHARGES

If your Merchandise Total is between:

$ 0.00–$ 4.99	add $2.00
$ 5.00–$24.99	add $1.00
$ 25.00–$49.99	add $0.75
$ 50.00–$99.99	add $0.50
$100 and Up	NO CHARGE

The above charges include shipping via First Class Mail or UPS (your choice), and insurance on all domestic shipments.

SPECIAL SHIPPING CHARGES

COD	$1.00 additional
UPS Blue	$1.00—additional
Postal Insurance	$1.00—additional
Special Delivery	$1.25—additional

INTERNATIONAL COMPONENTS CORPORATION

P.O.BOX 1837
COLUMBIA,MO. 65201
(314)-874-1150 OPEN SATURDAYS

CIRCLE NO. 33 ON FREE INFORMATION CARD

OPERATION ASSIST

(Continued from page 116)

Dumont oscilloscope, type 767. Service manual and horizontal time-base plug in. Larry Watson, Rt. 1, Box 180, Gadsden, AL 35901.

Telrad Frequency Standard Model 18A. Manufactured by **Fred E. Garner Co.**, Chicago. Circuitry needed. A.H. Ellis, 19 McClure Avenue, Brentford, Ontario, Can. N3R 4L7.

RCA TV model 8-PT-7030. Schematic and service data. P.J. Hughes, 1337 Weber Dr., Clearwater, FL 33516.

Standard Kollsman uhf converter model B, serial #59277. Schematic. Lynnie Gregory, Rt. 11, Box 211, Statesville, NC 28677.

Hickok model 610A TV-FM alignment generator. Tracy LaVere, Box 589 Garden Grove, CA 92642.

Hallicrafters model S-53A shortwave receiver. Schematic. R.C. Hartman, 2208 Bayberry St., Virginia Beach, VA 23451.

Conar Model 220 tube tester. Tube chart needed. Bob Swanberg, Box 96, Chelsea, MI 48118.

Tektronix model 511-AD oscilloscope. Manual and schematic. J.O. Dickinson, 1408 Monmouth Court West, Richmond, VA 23233.

Technics model RS-1030 US reel-to-reel tape deck. Service manual or schematic. Wallace Bonham, Box 94 Cape Girardeau, MO 63701.

Ross Electronics Corp cassette tape recorder, model #8282, serial #11404. Parts and schematic diagrams. A.T, Most, 4 Lanningan Drive, Lawrenceville, NJ 08648.

Webster WT-2 walkie-talkie. Need PTT switch or source of supply. Lamar Schwalke, P.O. Box 799, Florissant, MO 63033.

Hallicrafters Model S-36A. Operation manual or any available information. Chris Colson, 60 Deerhaven Place, Pleasant Hill, CA 94523.

Westinghouse model WR 226 3-band receiver. Schematic or service manual. Arthur Crough, RD 2, Bloody Pond Road, Lake George, NY 12845.

Hallicrafters model S-20-R "Sky Champion" receiver. All available information. J. Creasy, 824 Perry Highway, Apt. 15, Pittsburgh, PA 15229.

Roberts model 770X tape recorder. Service manual and/or schematic. Robert Fisher, 6536-14th St., Rio Linda, CA 95673.

Bell & Howell (DeVries Institute) Model 34 oscilloscope. Schematic and transformer voltage outputs or cross reference for replacement. Glenn T. Ozalan, 2220 NW Aspen, Portland, OR 97210.

Western Electric 25C amplifier. Specifications, schematic and parts list. W.Q. Cochran, 910 Townshipline, Chalfont, PA 18914.

Burroughs model C3100 electronic calculator. Schematic and repair information needed. C. Kline, 16 Old Farm Road, Barrington, IL 60010.

Allied Radio, Knight Star Roamer. Schematic and alignment procedure. M.F. Mattern, 1111 Warburton, Santa Clara, CA 95050.

Meisner phono disk recorder model #9-1065. **The Langevin Company** phono disk recorder, type 14A. Owners/operation manual and schematic for both units. D. Testa, Box 9064, Newark, NJ 07104.

Graymark model 506B two-band receiver. Schematic and manual. Henry M. Cantor, 21 Friendly Court, Babylon, NY 11702.

Hazeltine Neutrodyne receiver. Schematic or any available information. LeRoy Sampson, RR1, Radcliffe, IA 50230.

Superior Instruments tube tester model TV-11. Operating instructions. James Lewis, Box 6211, Tulsa, OK 74106.

Symphonic model TPS-5050, mini-TV. Need source of 3-inch picture tubes. Nicolas Dominquez, Ave. Pte., Tecamachalco No. 16, Mexico City, Mexico ZPIO.

Sears Model 9169 television receiver. Technical manual needed. W.A. Greenwood. 48 Third St., Leominster, MA 01453.

De Jur Model TK820 tape recorder. Mechanical, electrical

troubleshooting information, parts list. Walter Mesko, Box 210, Lake George, NY 12845.

Hallicrafters model S-38B shortwave receiver. Schematic and any available information. Ray Genest, 3175 Boul. Neilson, App. 3 Ste-Foy, Quebec 10, Can. G1W 2V7.

Morse color TV Model 7000. Service manual and parts list. J.C. Morall, 1000 Cottage Pl., Baldwin, NY 11510.

Webster-Chicago Model 80 wire recorder. Schematics and parts list, owner's manual. Mike Carey, Box 361, Highway 20, Madison, AL 35758.

Philco radio model 37-116, **Graybar** radio model 320, need chassis for both. **Philco** radio model #95, need cabinet. John Yeprad, Box 1457, Studio City, CA 91504.

Benson-Lehner Corp. digitizer "Pigmi" model. Need guide books and schmatics. W.E. Kelsey, Otter Pond Rd., New London, NH 03257.

Zenith Radio, model 770, chassis #1002204. Schematic and parts list. Ervin Thorson, RR5, Box 84 B, Martinsville, IN 46151.

Edin Co., Inc. Electrocardiograph model 8023 serial #4526. Schematic or any source of information. Russell H. Miller, Jr., 3609A N. Front St., Harrisburg, PA 17110.

Patterson model PR-15 communications receiver. Schematics and service manual. E.W. Clede, 6811 Spring Forest, San Antonio, TX 78249.

Grundig TK 46 tape recorder. Owner's manual and schematic. A. Haddad, 125 Jameson Ave., #508, Toronto, Ontario, M6K 2X3 Can.

National HRO-60 General Coverage Communications Receiver. Operation manual. R. Dennis Gibbs, 9214 Venetian Way, Richmond, VA 23229.

RCA regulated power supply model WP-33P. Schematic and service information. Roger A. Leone, 136 Delta Circle, Valle Jo, CA 94590.

Satellite S20B. Schematic and operation manual. Michael Unger, 183 S. Detroit St., Los Angeles, CA 90036.

Calbest Electronics, stereoplex model 6040 stereo receiver. Schematic and owner's manual. R.S. Dabe, 13400 Elsworth St., #39, Edgemont, CA 92508.

US Army R-5 receiver SN 20. Any information. George W. Anderson, 5317 Valonia St., Fair Oaks, CA 95628.

RCA model 6Q33 superheterodyne AM and shortwave receiver. Schematic or any available information. James Bias, Rt., 3, Box 175, Ridgeland, SC 29936.

Precision apparatus model #612 tube tester. Up-to-date roll. Ron Stanford, 8428 San Antonio Ave., South Gate, CA 90280.

Allied Radio Knight kit capacitor checker, kit #680. **Superior Instrument Company** multimeter model #670-A. **Jackson Dynamic** tube tester model 715. Manuals and schematics. W.L. Simpson, 370 Beagle Lane, Redding, CA 96001.

Hickok model 610A Universal Television FM alignment signal generator. Operation manual and schematic. Thomas E. Phillips, 404 E. Main St., West Newton, PA 15089.

RCA test oscillator WR-67A. Manual, schematic. W. Beale, Rt 1, Box 262A, Mechanicsville, MD 20659.

Omnitec model 701 acoustic coupler. Schematic. Ivan Berger, 215 W. 78th St., New York, NY 10024.

Precision Apparatus signal generator model E-200-C. Operating manual and schematics. Dan Williams, RD1, Stuyvesant, NY 12173.

Mitchell Industries, vhf navigator aircraft radio. Manuals, schematic. Dick Mayrand, 7 Maplewood, Rochester, NH 03867.

Weston vhf sweep generator model 984. Operating manual and schematic. Ron Patton, Country Ests. Pk-9B, Pratt, KS 67124.

Webcor 2712-1 tape recorder. Schematic and service data. Alfred E. Jordan, 897 E. Vine St., Salt Lake City, UT 84107.

Cathode-Ray oscillograph. Parts list and manual. Arthur Thompson, 26441 204 SE, Kent, WA 98031.

Triadex Muse electronic music computer. Schematic and service manual. Robert Stek, 19 Mayfield Rd., Regina, Saskatchewan, Can.

ABOUT YOUR SUBSCRIPTION

Your subscription to POPULAR ELECTRONICS is maintained on one of the world's most modern, efficient computer systems, and if you're like 99% of our subscribers, you'll never have any reason to complain about your subscription service.

We have found that when complaints do arise, the majority of them occur because people have written their names or addresses differently at different times. For example, if your subscription were listed under "William Jones, Cedar Lane, Middletown, Arizona," and you were to renew it as "Bill Jones, Cedar Lane, Middletown, Arizona," our computer would think that two separate subscriptions were involved, and it would start sending you two copies of POPULAR ELECTRONICS each month. Other examples of combinations of names that would confuse the computer would include: John Henry Smith and Henry Smith; and Mrs. Joseph Jones and Mary Jones. Minor differences in addresses can also lead to difficulties. For example, to the computer, 100 Second St. is not the same as 100 2nd St.

So, please, when you write us about your subscription, be sure to enclose the mailing label from the cover of the magazine—or else copy your name and address exactly as they appear on the mailing label. This will greatly reduce any chance of error, and we will be able to service your request much more quickly.

Philco "circuit master" VTVM. Need schematic, instruction and service manual. M. Carty, 2617 Wendell, Detroit, MI 48209.

General Radio, super MC-9, CB radio. Owner's manual, schematic or any available information. Nolly O. Byrd, 802 Spanish Ave., Pasagoula, MS 39567.

Flexowriter Model 2201-A. Schematics, any other information such as programming and interfacing. Jim Cooper, 651 Forest Ave., Paramus, NJ 07652.

National NC-120 manual or schematic. Adrian Hands, 7000 Whetstone, Alexandria, VA 22306.

Wurlitzer Juke Box model 1700 F. Service manual. Cliff Nadiger, 8073 Wonderlund Blvd., Redding, CA 96001.

Omnitec Model 800, portable terminal. Schematic. Stephen Karon, 601 Light St., Baltimore, MD 21230.

Kydo Electronics, Mypet 405 FM transceiver. Operation manual and schematics. Bill Cross, 3561 Milburn Ave., Baldwin, NY 11510.

RCA Model WO-33A oscilloscope. Operator's manual and schematic needed. Franklin B. Kovarik, 526 California Ave., E. Alton, IL 62024.

Hickok Model PS-503 power supply. Need owner's manual and/or schematic. S. Anderson 2020 N. 32 St. #112, Phoenix, AZ 85008.

RCA AR-88 receiver. Power transformer needed. Harold Donaldson, 8850 Phoenix Ave., Fair Oaks, CA.

ELECTRONICS LIBRARY

(Continued from page 115)

sumed, and due care is taken in presenting the basics of sound. The operating characteristics of EM "hardware," especially the synthesizer and tape recorder, are thoroughly explored. The functions of each component of a synthesizer (oscillator, sample and hold, etc.) and of a tape recorder (record, playback and erase heads, VU meters, etc.) are explained in readily understandable language. A textbook-like format is used, with suggested exercises given at the end of each chapter. But the book is not written in a dry, pedantic manner—it is hand lettered and illustrated in an entertaining and highly readable manner. It is equally suited for use in the classroom or on an individual basis in the home. Sound and Acoustics, Tape Recorder Husbandry, Creative Tape Work, Synthesizer Husbandry, Scoring, and Putting It All Together are the major areas covered. An appendix contains a glossary of technical terms, score sheets, and many sample synthesizer patches.

Published by Electronic Music Laboratories, Box H, Vernon, CT 06066. 168 pages (8½" × 11"). $6.95 ($5.50 each for three or more) soft cover.

OPERATIONAL AMPLIFIERS AND LINEAR INTEGRATED CIRCUITS

by R.F. Coughlin & F.F. Driscoll

This book demonstrates the ease of using op amps and other linear IC's in a variety of applications involving instrumentation, signal generation, and control. The basic op amp used throughout the book is the popular 741, which forgives most mistakes in wiring, ignores long-lead capacitance, and is rugged in operation. All circuits detailed in the text have been classroom and laboratory tested and have been selected to illustrate the tremendous range of applications where IC's can provide inexpensive solutions to practical problems.

Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. Hard cover. 312 pages $15.95.

THE COMPLETE HANDBOOK OF VIDEOCASSETTE RECORDERS

by Harry Kybett

Videocassettes are very much in the news lately, with the rapid emergence of several competitive home VCR systems. This handbook gives a thorough and detailed exposition of how VCR's work, and how to connect, use, and maintain them. Directed primarily at the professional user, the book discusses in detail the U-Matic system, which dominates the professional VCR field, and only mentions one of the current home systems, the Sony Betamax. But, the information given is basic enough to be applicable to all current and proposed VCR systems.

Published by Tab Books, Blue Ridge Summit, PA 17214. 280 pages. $9.95 hard cover. $5.95 soft cover.

Popular Electronics

ADVERTISERS INDEX

Electronics Classified

REGULAR CLASSIFIED: COMMERCIAL RATE: For firms or individuals offering commercial products or services, $2.40 per word. Minimum order $36.00. **EXPAND-AD® CLASSIFIED RATE:** $3.60 per word. Minimum order $54.00. Frequency discount; 5% for 6 months; 10% for 12 months paid in advance. **PERSONAL RATE:** For individuals with a personal item to buy or sell, $1.40 per word. No minimum! **DISPLAY CLASSIFIED:** 1" by 1 column (2-1/4" wide), $280.00. 2" by 1 column, $560.00. 3" by 1 column, $840.00. Advertiser to supply film positives. For frequency rates, please inquire.

GENERAL INFORMATION: Ad copy must be typewritten or clearly printed. Payment must accompany copy except when ads are placed by accredited advertising agencies. First word in all ads set in caps. All copy subject to publisher's approval. All advertisers using Post Office Boxes in their addresses **MUST** supply publisher with permanent address and telephone number before ad can be run. Advertisements will not be published which advertise or promote the use of devices for the surreptitious interception of communications. Ads are not acknowledged. They will appear in first issue to go to press after closing date. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st). Send order and remittance to Classified Advertising, **POPULAR ELECTRONICS**, One Park Avenue, New York, New York 10016, Attention: Hal Cymes.

FOR SALE

FREE! Bargain Catalog—I.C.'s, LED's, readouts, fiber optics, calculators parts & kits, semiconductors, parts. Poly Paks, Box 942PE, Lynnfield, Mass. 01940.

GOVERNMENT and industrial surplus receivers, transmitters, snooperscopes, electronic parts, Picture Catalog 25 cents. Meshna, Nahant, Mass. 01908.

LOWEST Prices Electronic Parts. Confidential Catalog Free. KNAPP, 3174 8th Ave. S.W., Largo, Fla. 33540.

ELECTRONIC PARTS, semiconductors, kits. FREE FLYER. Large catalog $1.00 deposit. BIGELOW ELECTRONICS, Bluffton, Ohio 45817.

RADIO—T.V. Tubes—36 cents each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

AMATEUR SCIENTISTS, Electronics Experimenters, Science Fair Students...Construction plans—Complete, including drawings, schematics, parts list with prices and sources...Robot Man — Psychedelic shows — Lasers — Emotion/Lie Detector — Touch Tone Dial — Quadraphonic Adapter — Transistorized Ignition — Burglar Alarm — Sound Meter...over 60 items. Send 50 cents coin (no stamps) for complete catalog. Technical Writers Group, Box 5994, University Station, Raleigh, N.C. 27607.

METERS—Surplus, new, used, panel or portable. Send for list. Hanchett, Box 5577, Riverside, CA 92507.

ROTARY SWITCH 4P11P 5/$5; 6P11P 5/$7.25. Dip Switch 10-SPST 10/$15. Transformers 12.2V CT-6A plus 8.5V-5A $6.95. 24V-5A $5.95. 10' RG58C/U 12/$10. Fertiks, 5249 "D", Philadelphia, PA 19120.

SOUND SYNTHESIZER KITS—Surf $12.95, Wind $12.95, Wind Chimes $17.95, Musical Accessories, many more. Catalog free. PAIA Electronics, Box J14359, Oklahoma City, OK 73114.

HEAR POLICE / FIRE Dispatchers! Catalog shows exclusive directories of "confidential" channels, scanners. Send postage stamp. Communications, Box 56-PE, Commack, N.Y. 11725.

UNSCRAMBLERS: Fits any scanner or monitor, easily adjusts to all scrambled frequencies. Only 4" square $29.95, fully guaranteed. Dealer inquiries welcomed. PDQ Electronics, Box 841, North Little Rock, Arkansas 72115.

UNREAL CATALOGS. Surplus, Factory Liquidations, Bankruptcy Inventories, Deals. Thousands of items at Bargain Surplus Prices. Rush $1. Etcoa Electronics, 521 5th Ave., NYC, NY 10017.

POLICE/Fire scanners, large stock scanner crystals, antennas. Harvey Park Radio, Box 19224, Denver, CO 80219.

TELETYPE EQUIPMENT for sale for beginners and experienced computer enthusiast. Teletype machines, parts, supplies. Catalogue $1.00 to: ATLANTIC SALES, 3730 Nautilus Ave., Brooklyn, NY 11224. Tel: (212) 372-0349.

WHOLESALE C.B., Scanners, Antennas, Catalog 25 cents. Crystals: Special cut, $4.95, Monitor $3.95. Send make, model, frequency. G. Enterprises, Box 461P, Clearfield, UT 84015.

TELEPHONES UNLIMITED, Equipment, Supplies, All types, Regular, Keyed, Modular. Catalog 50 cents. Box 1147E, San Diego, California 92112.

ORGAN KITS KEYBOARDS

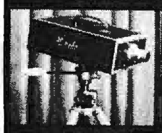
THE ULTIMATE IN DESIGN AND SOUND

Demo Record & Brochure $1.00

DEVTRONIX ORGAN PRODUCTS, Dept. C
5872 Amapola Dr. • San Jose, CA 95129

BUILD YOUR OWN TV CAMERA!

— Ideal for home & business —



THE ECONOMICAL ANSWER TO HOME MONITORING OF NURSERIES, ENTRANCES, DRIVEWAYS...BUSINESS and INDUSTRIAL SURVEILLANCE...ITV...AMATEUR TV PLUS HUNDREDS OF OTHER APPLICATIONS. MODEL XT-1A, SERIES D - KIT FORM $185; ASSEMBLED $275. SOLID-STATE. WORKS ON ANY TV SET. OPTIONAL SOUND KIT $28.95.

PHONE or WRITE for catalog. Dial 402-987-3771

1301 BROADWAY **ATV Research** DAKOTA CITY, NE. 68731

BUILD AND SAVE. TELEPHONES, TELEVISION, DETECTIVE, BROADCAST Electronics. We sell construction plans with an Engineering Service. Speakerphones, Answering Machines, Carphones, Phonevision, Dialers, Color TV Converters, VTR, Games, $25 TV Camera, Electron Microscope, Special Effects Generator, Time Base Corrector, Chroma Key. Engineering Courses in Telephone, Integrated Circuits, Detective Electronics. PLUS MUCH MORE. NEW Super Hobby Catalog PLUS year's subscription to Electronic News Letter, $1.00. Don Britton Enterprises, 6200 Wilshire Blvd., Los Angeles, Calif. 90048.

NAME BRAND Test Equipment. Up to 50% discount. Free catalog. Salen Electronics, Box 82, Skokie, Illinois 60076.

Build The Artisan Electronic Organ....

The 20th century successor to the classic pipe organ. Kits feature modular construction, with logic controlled stops and RAM Pre-Set Memory System. Be an ar·ti·san. Write for our free brochure. **AOK Manufacturing, Inc. P.O. Box 445, Kenmore, WA 98028.**

USED TEST EQUIPMENT — Tektronix, HP, GR. Write: PTI, Box 8699, White Bear Lake, MN 55110. Phone: (612) 429-2975.

WEATHER MAP RECORDERS: Copy Satellite Photographs, National-Local Weather Maps. Learn How! $1.00. Atlantic Sales, 3730 Nautilus Ave., Brooklyn, N.Y. 11224. Tel: (212) 372-0349.

AUDIO EXPERIMENTERS, Serious Music Synthesizer Stuff: literature, kits, components, circuits and more. Send SASE for FREE INFO. CFR Associates, POB F, Newton, NH 03858.

SURPLUS ELECTRONICS

ATTENTION HOBBYISTS — SEND FOR YOUR FREE CATALOG

Great buys in tape drives, keyboards, power supplies, and transformers. We also have heat sinks, steel cabinets, I/O terminals, video displays, printers, and equipment cases. And of course components, fans, wire, and cable. Write now to

Worldwide Electronics 10 Flagstone Drive Hudson, NH 03051

CB RADIOS, monitors, crystals, CD ignitions. Southland, Box 3591-B, Baytown, Texas 77520.

TRANSISTORS FOR CB REPAIR, IC's and diodes. TV audio repairs. 2SC799 — $3.00, 2SC1306 — $2.95, 2SC1307 — $3.85, TA7205— $3.50, more. Free catalog and transistor. B&D Enterprizes, Box 32, Mt. Jewett, PA 16740.

NEW PERIODIC TABLE OF ELEMENTS. Atomic physics breakthrough now reveals precise atomic models of each element. Striking wall chart, $3.00. Circlon, 29500 Greenriver Gorge, Enumclaw, WA 98022.

UNSCRAMBLER KIT: Tunes all scramble frequencies, may be built-in most scanners, 2-3/4 X 2-1/4 X 1/2. $19.95. Factory built Code-Breaker. $29.95. Free Catalog: KRYSTAL KITS, Box 445, Bentonville, Ark. 72712. (501) 273-5340.

SURPLUS COMPONENTS, Communication and test equipment. Illustrated catalog 25 cents. E. French, P.O. Box 249, Aurora, Illinois 60505.

MAKE YOUR PLANS COME TRUE by using electronic kit of Touch Switch, Patrol Car Siren, Sound Switch, Singing Bird. Each Kit $5.00 ppd. QMC, P.O. Box 4816, Irvine, California 92716.

$9.95 STEREO TUNE-UP

PINK NOISE GENERATOR

Uses latest digital MOS IC. See Radio-Electronics January, 1978 or write:

WEST SIDE ELECTRONICS
P.O. Box 636, Chatsworth, CA 91311

CARBON FILM RESISTORS 1/4W, 1/2W - 1.7 cents each. FREE sample / specifications. Other components. COMPONENTS CENTER, Box 295, W. Islip, New York 11795.

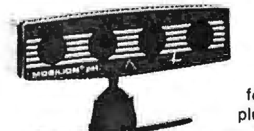
UNSCRAMBLE CODED MESSAGES from Police, Fire and Medical Channels. Same day service. Satisfaction guaranteed. Don Nobles Electronics, Inc., Rt. 7, Box 265B, Hot Springs, Arkansas 71901. (501) 623-6027.

made in Israel

Fit for Driving with

MOBILION CAR AIR IONISER

Drive in free refreshed unpolluted atmosphere. Car air loniser refreshes your air continuously. Get rid of smog, cigarette smoke, stale air.



Get your own mobilion unit for only $ 44.95 plus postage from:

THE AMCOR GROUP LTD.
P.O.Box 978, EDISON NEW JERSEY 08817

HIGH FIDELITY COMPONENTS. All top brands, distributor's prices. No-risk buying. No deposit. 48-hour delivery anywhere in Continental U.S. C.O.D. or charge card. Call: (301) 488-9600 daily till 9:00 P.M., Saturday till 4:00 P.M. or send $1.00 for brochure, buying tips, plus $2.00 merchandise certificate. INTERNATIONAL HI-FI DISTRIBUTORS, Moravia Center Industrial Park, Balto., MD 21206.

AMAZINGLY Low component prices! Ask for free flyer. Write: EEP, 11 Revere Place, Tappan, NY 10983.

UNSCRAMBLERS FOR any scanner. Several models available. Free literature. Capri Electronics, 8753T Windom, St. Louis, MO 63114.

FREE BARGAIN CATALOG, IC's, Semiconductors, Crystals. Send Stamp. Astral, P.O.B. 707 pes, Linden, N.J. 07036.

IC LSI wafers-3", fully processed. Many creative uses. $5.00. ESSAR, Box 326, Hicksville, N.Y. 11802.

GAME CHIP SETS, Pong, Handball, Hockey, MM57100, MM53103, LM1869 $5.10 sets $4.50 each, 100 sets $4 each. Complete game board, tested and working, $12. 3.58 MHZ Color Crystal $.50. 7490's $.25. RAMS 256X1 Intersil 5503 $.35. Summit Calculators, includes six AA Nicad cells, as is, most need only recharging, $4. $.50 postage on all orders. Don Allen, 7148 South 2985 East, Salt Lake City, Utah 84121.

ELECTRONIC
SURPLUS
FREE CATALOGS
ETCO ELECTRONICS, Dept. EB
North Country Shopping Center
Rt. 9N, Plattsburgh, N.Y. 12901

COUNTER, H.P. 524D 100MHZ like new. Baird, Rt. 5, Box 495, Berea, KY 40403.

REGENCY Touch $249.95. Bearcat 210 $249.95. (707) 544-4388. McDonald, Box 7492(P.), Santa Rosa, CA 95401.

30 WATT MOBILE STEREO AMP — Runs from 12VDC. Described P.E. Feb., 1976. Drilled Circuit Board, $4.50. Copy P.E. article $1.00. EBCO, 67 Forest View, Northford, CT 06472.

IC's — 100 assorted 7400 series — All Marked, $12.50 ppd. Send stamp for bargain list. Gull Electronics, 12690 Rte. 30, N. Huntingdon, PA 15642.

Triple Output Regulated DC Supply - compact DC supply ideal for microprocessor and memories, Model 477-3 supplies 5V at 500 ma, +12V at 100 ma and -5V at 200 ma regulated outputs, input 110V 60Hz, the unit is enclosed in a compact steel case and complete with AC line cord with fuse. Unit price $24.00. Lindtronics, P.O. Box 1792, North Brunswick, N.J. 08902.

PET owners need information?! Send SASE for details. TIS, Box 921, Los Alamos, NM 87544.

NAME BRAND TEST EQUIPMENT at discount prices. 72 page catalogue free. Write: Dept. PE, North American Electronics, 1468 West 25th Street, Cleveland, OH 44113.

BREAKERLESS ELECTRONIC ignition: Auburn Sparkplugs, Synthetic Lubricants, Wheel Stabilizers. Information 26 cents. Anderson Engineering, Epsom, N.H. 03234.

CB ANTENNA CONSTRUCTION MANUAL: Build 16 DB Gain Beams plus Quads, Verticals, Ground Planes using common hardware. East assembly/highest performance — Complete $4.00. Tenna-Farm, 1117 Dewitt Tr., Linden, N.J. 07036.

MAKE PC BOARDS. Step-by-step "how to" manual with build-it-yourself equipment plans, charts, and illustrations. For Polyez and Film-Chemical processes. $4.98 plus 50 cents P&H. Century American Instruments, Dept. 412, Box 1014, Placentia, CA 92670.

SURPLUS and Used Regency and Bearcat Scanners from $25.00. Crystals $3.95. Free Catalog. Action Surplus, 295 North Snelling, St. Paul, Minnesota 55104.

GIANT BARGAIN ELECTRONIC CATALOG listing thousands of components, tubes, transistors, IC's, kits, test equipment. Edlie's, 2700-1PA Hempstead Turnpike, Levittown, N.Y. 11756. Price $1.00 refundable with first order.

SCANNERS, BEARCAT 210 or Regency Touch $239.95, Two-Way Radios, Videotape Recorders. Free Catalog. Guilderland Communications, Box 591, Guilderland, N.Y. 12084.

NEW ADJUSTABLE, THREE OUTPUT, REGULATED, POWER SUPPLY, plus 900 parts worth over $400.00 in complete CARTRIVISION television electronic assembly. Documentation included. Perfect for MICROPROCESSOR and all electronic applications. $17.95 plus $3.50 S&H. Master Charge, BankAmericard. Free brochure. MADISON ELECTRONICS, 369, Madison, Alabama 35758. SATISFACTION GUARANTEED.

ADVENT VIDEOBEAM PROJECTION TELEVISION. 5, 6, & 7 foot screen, shipped anywhere. Amboy Television Center, 317 Hall Avenue, Perth Amboy, New Jersey 08861.

COMPUTER PARTS FALL-OUT — Sockets — Guides — Power Supplies — Core Memory Planes. Send $1.00 for a catalog. Refund first order. J&E Electronics, P.O. Box 4504, Fort Worth, Texas 76106.

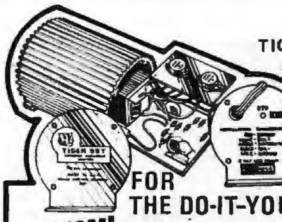
B&K Test Equipment. Free catalog. Free Shipping. Dinosaur discounts. Spacetron-AD, 948 Prospect, Elmhurst, IL 60126.

MULLEN COMPUTER BOARDS KITS: Extender Board with Logic Probe ($35) simplifies servicing. Relay/Opto-isolator Control Board ($117) interfaces to relays, triacs, etc. S-100 compatible. For details visit your computer store or write: Box 6214-A, Hayward, CA 94545.

PLANS AND KITS

AMAZING ELECTRONIC PRODUCTS
LASERS SUPER POWERED, RIFLE, PISTOL, POCKET - SEE IN DARK - PYROTECHNICAL, DE-BUGGING - UNCRAMBLERS - GIANT TESLA - STUNWAND - TV DISRUPTER - ENERGY PRODUCING, SCIENTIFIC DETECTION, ELECTRIFYING, CHEMICAL, ULTRASONIC, CB, AERO, AUTO AND MECH DEVICES, HUNDREDS MORE - ALL NEW PLUS INFO UNLTD PARTS SERVICE.
INFORMATION unlimited
CATALOG $1 Box 626 Lord Jeffery PZ. • Amherst, N.H. 03031

FREE KIT Catalog contains Test and Experimenter's Equipment. Dage Scientific Instruments, Box 1054P, Livermore, CA 94550.



TIGER SST
SIMPLI-KIT
FOR THE DO-IT-YOURSELFER
NOW! a high quality CD Electronic Ignition System in kit form.
Contains all components and solder to build complete Solid-State Electronic CD Ignition System for your car. Assembly requires less than 3 hours.
- Increases MPG 15%
- Increases horsepower 15%
- Plugs and Points last 50,000 miles
- Eliminates 4 of 5 tune-ups
- Instant starting, any weather
- Dual system switch

Fits only 12 volt neg. ground... Only $21.95 postpaid
Tri-Star Corporation
P.O. Box 1727 Grand Junction, Colorado 81501

MIXERS—Preamps—Speakers, Top Quality Kits—Plans—Parts. Send 25 cents for catalog. Audio Design & Engineering Co., P.O. Box 154, Lee, Mass. 01238. (413) 243-1333.

FIVE LASER PLANS — $8.00; Welding-Burning Laser plans — $9.00. Catalog $2.00. Solaser, PE 478, Box 1005, Claremont, California 91711.

BUILD YOUR OWN SYMPHONY OF SOUND!

It's fun and easy—takes just minutes a day! Complete kits for organs, pianos, strings, rhythms, amplifiers, synthesizers. Also factory assembled. 104-page catalog $2.00
WERSI
Wersi Electronics, Inc., Dept. ZD, Box 5318, Lancaster, PA 17602.

QUALITY KITS, over 7,000 schematics. $1 (refundable) for illustrated catalog. Tek-Devices, Box 19154c, Honolulu, HI 96817.

ROBOT PLANS That Work! $5.00. American Robots, Dept. E., P.O. Box 1304, Tulsa, OK 74101.

CB/HAM-OMNIPOLARIZED BASE ANTENNAS. Modulation boosting VOX-COMPRESSOR. Portable / mobile / memory, 300 MHz FREQUENCY COUNTER. Complete plans $3.00 each. $7.50 / all. MANY OTHERS! Catalog — PANAXIS, Box 5516-A4, Walnut Creek, CA 94596

TUBES

RADIO & T.V. Tubes—36 cents each. Send for free Catalog. Cornell, 4213 University, San Diego, Calif. 92105.

TUBES: "Oldies", Latest. Supplies, components, schematics. Catalog Free (stamp appreciated). Steinmetz, 7519-PE Maplewood, Hammond, Ind. 46324.

FREE BARGAIN CATALOG, Industrial, Ham, Receiving Tubes. Send Stamp. Astral, P.O.B. 707 pet, Linden, N.J. 07036.

TUBES Send 10 cents for large conclusive list. Low Prices. T-J Specialties, Box 43, Bradley Beach, New Jersey 07720. (201) 774-8429.

TUBES-RECEIVING, Industrial and Semiconductors Factory Boxed. Free price sheet including TV, Radio and audio parts list. Low, low prices. Transleteronic, Inc., 1365 39th St., Brooklyn, New York 11218. Telephone: (212) 633-2800. Toll free: 800-221-5802.

1,000 TYPES including obsoletes. Popular types up to 85% off list, pullouts from 29 cents. Free catalog and $1.00 certificate. Connolly, POB 1333P, Sun Valley, Calif. 91352.

ALARMS

QUALITY BURGLAR/FIRE ALARM equipment at discount prices. Catalog 50 cents. Steffens, Box 624C, Cranford, N.J. 07016.

DON'T PURCHASE alarm equipment before getting our free value packed catalog. Sasco, 5619-C St. John, Kansas City, MO 64123. (816) 483-4612.

WANTED

GOLD, Silver, Platinum, Mercury wanted. Highest prices paid by refinery. Ores assayed. Free circular. Mercury Terminal, Norwood, MA 02062.

HIGH FIDELITY

DIAMOND NEEDLES and Stereo Cartridges at Discount prices for Shure, Pickering, Stanton, Empire, Grado and ADC. Send for free catalog. LYLE CARTRIDGES, Dept. P, Box 69, Kensington Station, Brooklyn, New York 11218. For Fast Service call Toll Free 800-221-0906.

INSTRUCTION

LEARN ELECTRONIC ORGAN SERVICING at home all makes including transistor. Experimental kit—troubleshooting. Accredited NHSC, Free Booklet. NILES BRYANT SCHOOL, 3631 Stockton, Dept. A, Sacramento, Calif. 95820.

SCORE high on F.C.C. Exams...Over 300 questions and answers. Covers 3rd, 2nd, 1st and even Radar. Third and Second Test, $14.50; First Class Test, $15.00. All tests, $26.50. R.E.I., Inc., Box 806, Sarasota, Fla. 33577.

UNIVERSITY DEGREES BY MAIL! Bachelors, Masters, Ph.D's. Free revealing details. Counseling, Box 317-PE04, Tustin, California 92680.

SELF-STUDY CB RADIO REPAIR COURSE. THERE'S MONEY TO BE MADE REPAIRING CB RADIOS. This easy-to-learn course can prepare you for a career in electronics enabling you to earn as much as $16.00 an hour in your spare time. For more information write: CB RADIO REPAIR COURSE, Dept. PE048, 531 N. Ann Arbor, Oklahoma City, Okla. 73127.

LEARN WHILE ASLEEP! HYPNOTIZE! Astonishing details, strange catalog free! Autosuggestion, Box 24-ZD, Olympia, Washington 98507.

GRANTHAM'S FCC LICENSE STUDY GUIDE — 377 pages, 1465 questions with answers/discussions — covering third, second, first radiotelephone examinations. $13.45 postpaid. GSE, P.O. Box 25992, Los Angeles, California 90025.

INTENSIVE 5 week course for Broadcast Engineers. FCC First Class license. Student rooms at the school. Radio Engineering Inc., 61 N. Pineapple Ave., Sarasota, FL 33577 and 2402 Tidewater Trail, Fredericksburg, VA 22401.

1978 "TESTS - ANSWERS" for FCC First Class License. Plus - "Self-Study Ability Test." Proven! $9.95. Moneyback Guarantee. Command Productions, Box 26348-P, San Francisco, CA 94126.

BROADCAST STATION: Start your own. Any type! Home, school, church, business operation. Get free equipment, records. Details free. "Broadcasting", Box 5516-A4, Walnut Creek, CA 94596.

MATHEMATICS, Electronics, satisfaction guaranteed. Indiana Home Study, Dept. PE, Box 1189, Panama City, FL 32401.

PASS YOUR FCC EXAMS. New tests by noted Author and Teacher. 500 Questions Second Class, $11.95; 200 First Class, $7.95; 100 Radar, $4.95; Postpaid. Save, all three, $19.95. Complete Mathematical Solutions. Free Counselling Service. Victor Veley, P.O. Box 14, La Verne, Calif. 91750.

ELECTRONICS PROGRAM. Used in industry. Transistors to Micro Processors. FCC preparation. Troubleshooting. Many experiments. Reasonable. A.L.I. Schools, 6501 NW 14 St., Plantation, FL 33313.

TAPE AND RECORDERS

8-TRACK and CASSETTE BELTS — money back guarantee. Long wearing. Free Catalog — $3 minimum order. PRB Corp., Box 176, Whitewater, Wisconsin 53190. (800) 558-9572 except WI.

TAPE HEAD CLEANER. 8 oz. — $2.30. Includes postage and handling. Write: "Cleaner", Box 176, Whitewater, WI 53190.

RECORDS — TAPES! Discounts to 73%; all labels; no purchase obligations; newsletter; discount dividend certificates; 100% guarantees. Free details. Discount Music Club, 650 Main St., Dept 5-0478, New Rochelle, New York, N.Y. 10801.

GOVERNMENT SURPLUS

MANUALS for Govt Surplus radios, test sets, scopes. List 50 cents (coin). Books, 7218 Roanne Drive, Washington, D.C. 20021.

GOVERNMENT SURPLUS. Buy in your Area. How, where. Send $2.00. Surplus, 30177-PE Headquarters Building, Washington, D.C. 20014.

JEEPS — $59.30! — Cars — $33.50! — 200,000 ITEMS! — GOVERNMENT SURPLUS — Most COMPREHENSIVE DIRECTORY AVAILABLE tells how, where to buy — YOUR AREA — $2.00 — MONEYBACK GUARANTEE — Government Information Services, Department GE-13, Box 99249, San Francisco, CA 94109 (433 California).

PERSONALS

MAKE FRIENDS WORLDWIDE through international correspondence. Illustrated brochure free. Hermes-Verlag, Box 110660/Z, D-1000 Berlin 11, Germany.

RUBBER STAMPS

RUBBER STAMPS, BUSINESS CARDS. Many new products. Catalog. Jackson's, Dept. K, Brownsville Rd., Mt. Vernon, Ill. 62864.

BOOKS AND MAGAZINES

FREE book prophet Elijah coming before Christ. Wonderful bible evidence. Megiddo Mission, Dept. 64, 481 Thurston Rd., Rochester, N.Y. 14619.

POPULAR ELECTRONICS INDEXES For 1976 now available. Prepared in cooperation with the Editors of "P/E," this index contains hundreds of references to product tests, construction projects, circuit tips and theory and is an essential companion to your magazine collection. 1976 Edition, $1.50 per copy. All editions from 1972 onward still available at the same price. Add $.25 per order for postage and handling, $.50 per copy, foreign orders. INDEX, Box 2228, Falls Church, Va. 22042.

REPAIRS AND SERVICES

SERVICEMEN — Cleaners, Lubricants, Adhesives for all electronic repairs. Write for FREE catalog. Projector-Recorder Belt Corp., Box 176, Whitewater, WI 53190. 800-558-9572 except WI.

PRINTING, Rubber Stamps, Low Prices, Fast Service. Free Catalog. Magestro's Printing, North Ave., New Brighton, PA 15066.

EMPLOYMENT OPPORTUNITIES

ELECTRONICS/AVIONICS EMPLOYMENT OPPORTUNITIES. Report on jobs now open. Details FREE. Aviation Employment Information Service, Box 240E, Northport, New York 11768.

RADIO-TV Jobs... Stations hiring nationwide! Free details: "Job Leads," 1680-FA Vine, Hollywood, CA 90028.

HYPNOTISM

SLEEP learning. Hypnotic method. 92% effective. Details free. ASR Foundation, Box 23429EG, Fort Lauderdale, Florida 33307.

FREE Hypnotism. Self-Hypnosis. Sleep Learning Catalog! Drawer H400, Ruidoso, New Mexico 88345.

AMAZING self-hypnosis record releases fantastic mental power. Instant results! Free trial. Write: Forum (AA4), 333 North Michigan, Chicago 60601.

INVENTIONS WANTED

INVENTORS

RECOGNITION...FINANCIAL REWARD...OR CREDIT

FOR "INVENTING IT FIRST" MAY BE YOURS!

If you have an idea for a new product, or a way to make an old product better, contact us, **"the idea people"** We'll develop your idea, introduce it to industry, negotiate for cash sale or royalty licensing.

Write now without cost or obligation for free information. **Fees are charged only for contracted services.** So send for your **FREE "Inventor's Kit."** It has important **Marketing Information**, a special **"Invention Record Form"** and a **Directory of 1001 Corporations Seeking New Products.**

the idea people

RAYMOND LEE ORGANIZATION
230 Park Avenue North, New York, NY 10017

At no cost or obligation, please rush my **FREE "Inventor's Kit No. A-112"**

Name ____
Address ____
City ____ State ____ Zip ____
Phone No. ____ Area Code ____

FREE PAMPHLET: "Tips on Marketing Your Invention", from an experienced fee-based invention service company. Write: United States Inventors Service Company, Dept. T, 1435 G Street NW, Washington DC 20005.

IDEAS, INVENTIONS, New Products needed by innovative manufacturers. Marketing assistance available to individuals, tinkerers, universities, companies with feasible concepts. Write for Kit-PE, 12th Floor, Arrott Building, Pittsburgh, PA 15222.

BUSINESS OPPORTUNITIES

I MADE $40,000.00 Year by Mailorder! Helped others make money! Free Proof. Torrey, Box 318-NN, Ypsilanti, Michigan 48197.

FREE CATALOGS. Repair air conditioning, refrigeration. Tools, supplies, full instructions. Doolin, 2016 Canton, Dallas, Texas 75201.

MAILORDER MILLIONAIRE helps beginners make $500 weekly. Free report reveals secret plan! Executive (1K4), 333 North Michigan, Chicago 60601.

GET RICH with Secret Law that smashes debts and brings you $500 to $5 Million cash. Free report! Credit 4K4, 333 North Michigan, Chicago 60601.

HIGHLY PROFITABLE ONE-MAN ELECTRONIC FACTORY

Investment unnecessary, knowledge not required, sales handled by professionals. Postcard brings facts about this unusual opportunity. Write today! Barta-DD, Box 248, Walnut Creek, CA 94597.

NEW LUXURY Car Without Cost. Free Details! Codex-ZZ, Box 6073, Toledo, Ohio 43614.

GET RICH!!! Secret law erases debts. Free report exposes millionaire'$$ secrets. Blueprints, No. EE4, 453 W. 256, NYC 10471.

MECHANICALLY INCLINED Individuals desiring ownership of Small Electronics Manufacturing Business — without investment. Write: BUSINESSES, 92-K2 Brighton 11th, Brooklyn, New York 11235.

MILLIONS in Mail!! Free Secrets. Transworld-17, Box 6226, Toledo, OH 43614.

RECEIVE MONEYMAKING OFFERS GALORE! Your name listed nationally $1.00. Zodiac, P.O. Box 12310-PE, East Cleveland, Ohio 44112.

STUFF ENVELOPES, $25.00 hundred. Immediate earnings. Send addressed, stamped envelope to: M&D Company, Box 172, Winchester, OR 97495.

RECEIVE MONEYMAKING OFFERS GALORE! Your name listed nationally $1.00. Zodiac, P.O. Box 12310-PE, East Cleveland, Ohio 44112.

$650 WEEKLY for beginners!! Free report: Mailorder Consultants MEE4, 453 W256, NYC 10471.

$3000.00 MONTHLY. Start immediately. Stuff envelopes at home. Information, send self-addressed stamped envelope. Village, Box 508-HGD, West Covina, CA 91706.

EARN IMMEDIATELY STUFFING ENVELOPES. $300.00 thousand possible. Free supplies. Send self-addressed stamped envelope. Salamon Industries-PE6, 6059 W. 55th St., Chicago, IL 60638.

SELL BOOKS BY MAIL — 400% Profit. Be your own boss. Free Details. JB Enterprises, Box 595 (PE), Stn. Q, Toronto, Canada M4T 2N4. U.S. Inquiries.

HOME ENTERTAINMENT FILMS

SAVE MONEY on World Famous Universal 8 Sound Films: Sweet Charity; Great Waldo Pepper; Thoroughly Modern Millie; Airport; Jesus Christ Superstar — each 400' S-8 color sound in new plastic storage box, $43.95 ea (add $1 per film shipping). Silent, New! 400' B&W The Best of Abbott & Costello (Pt. I & Pt. II), $29.95 ea (+ $0.80 ea for ship.). All 200' S-8 Color Sound — Star Wars; Frank Sinatra in The Detective; The Poseidon Adventure — $27.95 ea (mail order price). Penny Pinchers: Apollo XV, The Ride of the Rover; Tunney/Gibbons; Tunney/Heeney — S-8 B&W, $5.95 ea delivered. Current Columbia Pictures catalog (soon to be a collector's item), $1.00; New Universal 64-pg 4-color catalog, $1.00; Sportlite and Universal film lists, $0.35 ea. SPORTLITE FILMS, Elect-4/78, Box 24-500, Speedway, Indiana 46224.

DO-IT-YOURSELF

MODULAR TELEPHONES now available. Sets and components, compatible with Western Electric concept. Catalog 50 cents. Box 1147W, San Diego, California 92112.

TAPE-SLIDE SYNCHRONIZER, lap-dissolve, multiprojector audiovisual plans $8.50. Free Catalog. Millers, 1896 Maywood, South Euclid, OH 44121.

REAL ESTATE

BIG... FREE... CATALOG! Over 2,500 top values coast to coast! UNITED FARM AGENCY, 612-EP, West 47th, Kansas City, MO 64112.

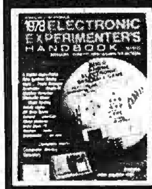
MUSICAL INSTRUMENTS

UP TO 60% DISCOUNT. Name brand instruments catalog. Freeport Music, 114 G. Mahan St., W. Babylon, N.Y. 11704.

MISCELLANEOUS

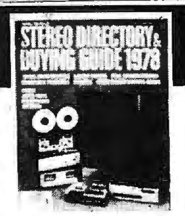
MPG INCREASED! Bypass Pollution Devices easily. REVERSIBLY!! Free details—Posco GEE4, 453 W. 256, NYC 10471.

1978 Electronic Experimenter's Handbook



This latest edition includes a Hobbyist and Microcomputer Section! It also features a host of exciting construction projects with complete construction plans, parts lists and printed-circuit board patterns. PLUS —A complete Home Computer Buying Directory with product specifications, latest prices, and photos. Only $1.95!

Order your copy from ELECTRONIC EXPERIMENTER'S HANDBOOK, P.O. Box 278, Pratt Station, Brooklyn, New York 11205. Enclose $2.50* ($1.95 plus 55¢ postage and handling). Outside U.S.A. $3.
*Residents of CA, CO, FL, IL, MI, MO, NY STATE, DC and TX add applicable sales tax (Postage and handling charges non-taxable).



1978 STEREO DIRECTORY & BUYING GUIDE

All the latest information on stereo and quadraphonic systems and components for your home. A complete guide to more than 2000 products in all —with complete specifications, descriptions and prices. PLUS bonus feature articles. A must for anyone concerned with good sound.

Order from STEREO DIRECTORY, P.O. Box 278, Pratt Station, Brooklyn, New York 11205. Enclose $3.00* ($2.50 plus 50¢ for postage and handling).
*Residents of CA, CO, FL, IL, MI, MO, NY STATE, DC and TX add applicable sales tax. (Postage and handling charges non-taxable.)

ELECTRONICS WORLD® News Highlights in Brief

Creating Signature Profiles

The use of a person's signature as a means of identification may be furthered by the development at Sandia Laboratories of a special pen and tablet which sense three supposedly unique characteristics of a person's signature. In the pen are two piezoelectric bimorph bender elements, bonded along adjacent quadrants of a slightly flexible aluminum shaft. As a signature is written, one of these transducers generates a horizontal acceleration signal while the other detects vertical acceleration. A third set of signals is generated by pressure-sensitive transducers in the writing tablet. The three output signals, which have peak amplitudes on the order of one volt on each axis and require no biasing current or external power supply, can be processed by a computer and compared with a file record retrieved from the computer's memory. The signature verification system is expected to be useful in banks, department stores, and other institutions where personnel identification is required.

Ham Radio and Storm Spotting

The National Weather Service, which already has more than 200 weather stations and 51 storm detection radars linked by an extensive radio network, has also turned to Amateur Radio Service operators to fill some of the gaps in the reporting nets. Hams are already functioning efficiently as severe storm spotters and communicators for the NWS in the Tulsa, Okla., and Dallas-Fort Worth and Waco, Texas areas. Cooperation with hams in other tornado-prone areas of the U.S. is being developed. Interested amateurs in a particular area are contacted by the local Weather Service official and the spotting and communications needs are explained. Frequencies to be used (usually in the 2-meter band) are determined, and the system activation procedure is established. Persons interested in cooperating should request copies of the publication "Amateur Radio and the National Weather Service" to: Headquarters, Southern Region, National Weather Service, Rm. 10E09, Federal Office Bldg., Fort Worth, TX 76102.

FCC CB Slide Show

The Federal Communications Commission has produced a 10-minute cartoon slide-and-sound show about Citizens Band rules. The title is "10-4 Uncle Charlie," and it was developed to explain, in an entertaining format, the importance of the rules to the thousands of new operators who go on the air every month. The program includes 72 slides, a 10-minute audio tape cassette, a script and a question-and-answer sheet. Clubs, schools, and others interested in CB can purchase the show package for $15 (checks payable to the National Archives Trust Fund) from: National Audiovisual, Center General Services Administration, Order Section, Washington, DC 20409.

Record Awards for Good Sound

Record awards are based primarily on musical content—only secondarily on sound. The new Audio Excellence Record Awards, sponsered by Audio-Technica, are based primarily on sound. Winner in the rock/pop division was Stevie Wonder's "Songs in the Key of Life" (Tamla 13-340C2). In the classical division, the winner was "Caruso—A Legendary Performer" (RCA CRM1-1749). What garnered this sound-oriented award for a record based on masters more than 50 years old was a computer process that eliminated much of the original discs' surface noise and the resonances of the recording horns, giving Caruso's voice a more modern recorded quality. Among the factors for which the records were cited were: cleanliness of sound, instrumental and vocal balance, emphasis, dynamic range, frequency response, low noise, and stereo separation as well as dispersion.

Electronic Blackboard Transmits Data

The Bell System has developed a new blackboard, which, with the proper electronic equipment, can be used to transmit handwriting over phone lines for display on video monitors at distant locations. Used with a portable conference telephone equipped with microphones and a loudspeaker, the electronic blackboard can bring an instructor's entire presentation across the campus. The board consists of a rigid back layer and a front layer that is a thin sheet of black Mylar stretched tightly over the frame. The inner surfaces of both layers are electrically conductive and act as X-Y lines. Pressing the board with a piece of chalk registers a point at the intersection of the two axes. When the chalk is moved, a memory unit retains the dots so they blend together to form a line on the remote monitor. To erase, a device, normally resting on the control unit, is lifted so that the dot-by-dot process is reversed and the image is erased wherever pressure is applied.

Electronics in the Postal Service

If the U.S. Postal Service is to serve the public adequately and be competitive with other communications systems in the country, it is going to have to start using more electronic techniques. Such was the advice of a recent study by a Commission on Postal Service in its report to the Congress and the President. For example, the commission noted that it is now technologically possible, though not yet economically feasible, to transmit more than 50 percent of the entire volume of mail by electronic means. This is partially due to the fact that about 80 percent of first-class mail today is business-related—invoices, bills, payments, etc. The Electronic Funds Transfer systems are expected to handle 1.9 billion pieces of mail by 1980 and 6.56 billion by 1985, according to a study made by Arthur D. Little, Inc. Similarly, the Treasury Department is expanding its system of direct deposit of payments in many categories.

ANIXTER-MARK
Introduces the
heliwhip™ Broad Stick™

The new SUPERSTAR Antenna

heliwhip Broad Stick™

It's Rugged!

Because it's tested up to 700 Watts

It's Broad!

Constant VSWR Across 40 Channels

THE BROAD STICK is the first *totally new concept* in top loaded CB antenna design. In 1957 Anixter-Mark originated the industry standard — the Heliwhip™. Now, a new industry standard — THE BROAD STICK. Designed for *maximum power* output and input, THE BROAD STICK has been tested up to *700 watts* and provides constant VSWR across 40 channels . . . high operating efficiency because it's wound with 32′ (7/8 wave-length) of heavy gauge wire . . . separate loading and matching coils and much, much more! THE BROAD STICK. It's all new from ANIXTER-MARK and it's a beaut!

THE *little devil*™
CB Antenna Adaptor.

Used for upgrading to a higher performance antenna, fits any 5/8″-24 thread mount, accepts any 3/8″-24 antenna including the "Heliwhip." No new mount or cable is needed with this adaptor. Model HWA-1.

Quick-On Connect

Chrome plated connector for rapid removal of "Heliwhip." Simply twist for removal. Fits all antennas and mounts with 3/8″-24 thread, including the "Heliwhip." Model QOC.

Mark V Base Station Antenna

The Mark V is a full 20 ft. tall. It is extremely sturdy and designed for heavy-duty commercial use. Lowest VSWR over the greatest bandwidth. Supplied with universal mast mounting kit — mounts on any pipe with O.D. from 1″ to 1¾″ Model MK-V.

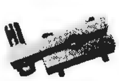
the dude

Top loaded CB antenna with CLASS!

Anixter-Mark's new standard of excellence. Combines sturdy heliwhip fiberglass construction with a heavy brass chrome plated mast. Height 54″. Tuning Range 26.9-27.5 MHz. Model AAC-11-4.

Great Gripper

"THE GREAT GRIPPER" gives you a totally designed package including:
★ Super powerful ceramic magnets
★ New antenna design to complement the mount
★ A full 18 feet of cable
Fiberglass and top loaded, THE GREAT GRIPPER antenna looks sleek and slim in black and chrome. And it's a 40 channel antenna — with an average VSWR of 1.4:1 over all 40 channels. Model MAR-11-S3.



Heavy Duty Truck Mirror Mount

Heavy duty aluminum mount with gripping teeth in both pieces, bites through paint for good ground connection. Chrome plated ferrule with 3/8″-24 thread. Clamps up to 1 7/16″ pipe. Model HWM-12.

ANIXTER-MARK
Manufacturers of a Full Line of Point-To-Point Antennas
Microwave • Two-Way • Amateur • CB
5439 W. Fargo, Skokie, IL 60076 (312) 675-1500
Made in U.S.A.

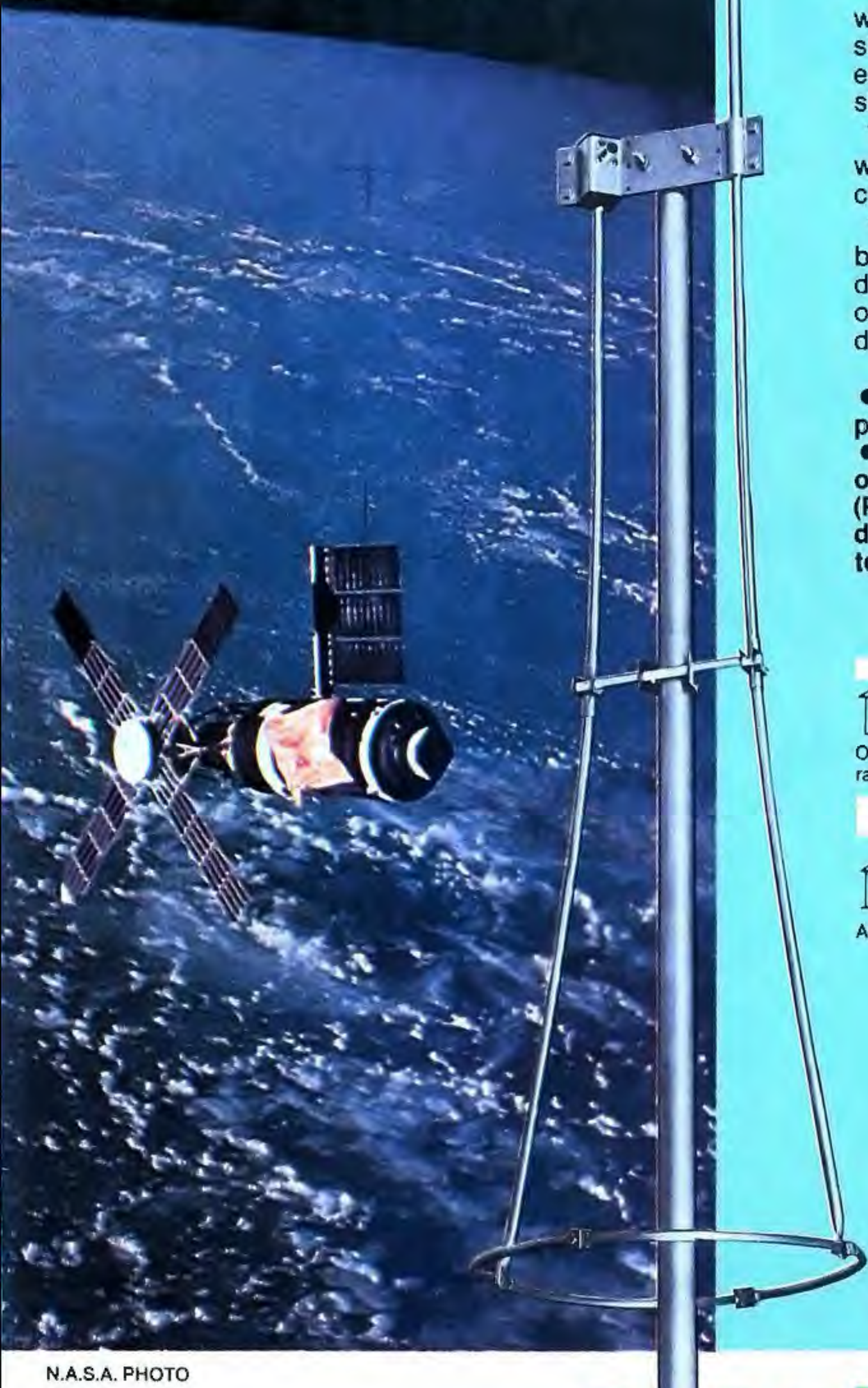
CIRCLE NO. 4 ON FREE INFORMATION CARD

ANIXTER-MARK PE 4/78
5439 W. Fargo
Skokie, IL 60076
(312) 675-1500

Please send me additional information on the BROADSTICK and the other fine Anixter-Mark products.

NAME__________ PHONE__________
COMPANY__________
ADDRESS__________
CITY__________ STATE__________ ZIP__________

AVANTI® ASTRO PLANE™ CB Base Antennas give you patented performance!



N.A.S.A. PHOTO

CO-INDUCTIVE design of this patented antenna gives long range, noise free performance.

The result of years of research & development, the ASTRO PLANE has top radiation which means that your signal gets out from the highest part of your antenna. Your signal radiates about 15 feet higher than with other antennas which radiate near the bottom.

The ASTRO PLANE has a lower angle of radiation which makes more efficient use of the radiated signal by allowing it to hug the curvature of the earth instead of shooting your power up into the sky.

The ASTRO PLANE has 4.46 db gain over isotropic which gives you a stronger signal and better, clearer reception.

You'll get long lasting, trouble free performance because it is compact in design — without long drooping radials, without coils to burn or short out, and with direct ground construction to help dissipate static charges and lightning.

• Stainless steel radials concentrate signal power on top • Rigid heavy-duty aluminum tubing • No long drooping radials to ice up or break off • So unique it's backed by a U.S. patent (Patent #3587109) • No coils to burn out or detune • Easy assembly • Lightweight — easy to install on simple pipe mast

Ordinary collinear or ground plane antenna signals are blocked...they radiate from the bottom.

ASTRO PLANE gets its signal over obstacles...it radiates from the top.

SPECIFICATIONS

Total Length — 12 feet	Vertical Polarity
Weight — 4 lbs.	Aircraft Quality Aluminum
Power Gain — 4.46 db	SWR — Pre-tuned — Less than 1.2:1
Impedance — 50-52 ohms	
Omnidirectional — needs no rotor	band width — full 40 channels

high performance CO-INDUCTIVE™ *antennas*

Avanti makes a complete line of high performance mobile CB antennas and accessories. For free catalog, write:

avanti

creators of the famous MOONRAKER®

AVANTI RESEARCH AND DEVELOPMENT, INC., 340 Stewart Avenue, Addison, IL 60101

CIRCLE NO. 8 ON FREE INFORMATION CARD